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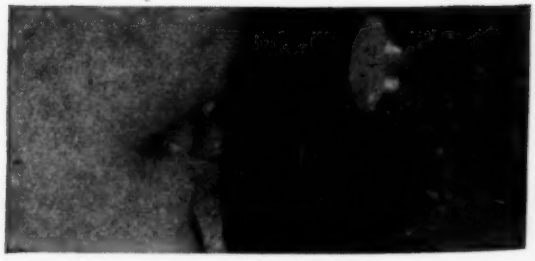

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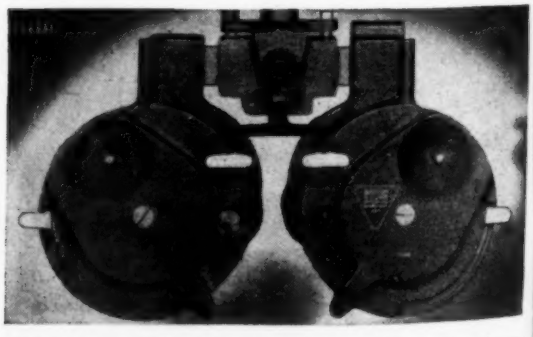

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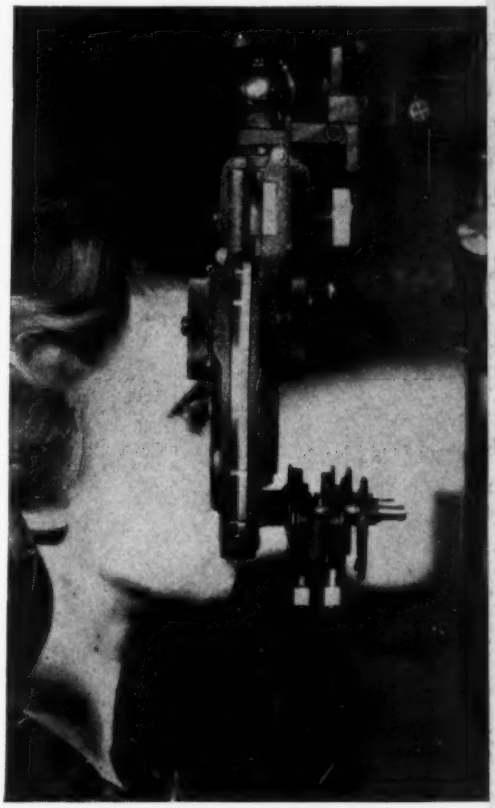

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A DISCUSSION OF THE NEUROLOGICAL RESPONSES EVOKED BY THE USE OF SYNTONICS*

Theodore Cohen, O.D., F.C.S.O.
New York, N. Y.

The subject of this discussion is Syntonics, and at the outset, therefore, I think that it would be well to define the term. Webster defines Syntonics and Syntony in terms of physics, as the state of being adjusted to a certain wave length; agreement or tuning between the time periods of an apparatus. Syntonic is also defined as being the "state of syntony between transmitting and receiving apparatuses." These definitions obviously do not apply to physiologic processes, but are limited to mechanisms which may be caused to have equal tensions and masses in order that they may be tuned together, i.e., to the same frequency or pitch.

Bleuler is generally credited with the first use of the term Syntonic, in the field of physiology of the nervous system, to describe a stable integrated type of personality. Syntonic is also used in the adjective form to indicate a balanced integrated nervous system particularly the autonomic. In this division there exists a state of dynamic antagonistic tensions between its two outflows, the sympathetic (or thoracico-lumbar) and the parasympathetic (or sacral outflow). When these tensions are equal the nervous system is said to be in Syntony or in the Syntonic state. It is this connotation that we will use in this discussion.

Permit me to say at the start, that I am indebted to Dr. H. Riley Spitler the author of *"The Syntonic Principle"* for much of my material. It has long been a matter of common observation that individuals react differently to the same stimulus, even though in the same environment. Blood brothers, even identical twins are known to vary in their responses to the same stimulus. Many efforts have been made to account for these differences. Environment, heredity, nutrition have all been considered. Let us for a moment consider some of the environmental factors which are common to all, and which factors are found to vary as between individuals.

The first common factor obviously, is heredity which while admittedly varying as between families, does not vary for individuals of the same family. It seems then that heredity cannot be the factor sought.

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*An abridgment of the material presented before the Omega Epsilon Phi Fraternity at Columbia University, New York City, March 29, 1940. Submitted for publication July 22, 1940.

A second factor, the school and family environment may be considered. Within each family, so far as food, housing and clothing is concerned, we find a practical constant *for that family*. Within certain limits, the school life of the individual, at least of each member of any class is a constant.

A third factor would be endocrine differences as between individuals. Here we find wide differences between members of the same family as well as differences between all individuals of the race. The endocrine factor is inherent in each individual and varies from day to day in that individual. As yet no suitable criteria have been established for evaluating endocrine differences.

A fourth factor would be food intake, but that not only varies as between individuals but also in terms of communities, races, religions and geographical location. No criteria obviously can be set up for the evaluation of this factor.

The one constant, is that of the several forms of radiant energy absorbed by the individual. This factor does not vary between individuals because all living things are subject to the absorption of the same energy simultaneously. There are, of course, as you already know, a number of forms of radiant energy, for example, Hertzian waves such as are commonly used in wireless telegraphy, and infra-red radiations, a low frequency radiation too low to stimulate the photo-receptors in the eye. The absorption of infra-red radiation results in heat, and does vary between individuals, due to differences of body coloring and rate of metabolism. This variation, however, is relatively small, so small as to have little or no significance to the problem under consideration. A third form of radiant energy is the photic range, or the so-called visible range. This form of energy varies for each individual at all times due to selective absorption of light by transmitting or reflecting media or bodies. It seems that here we have the factor which can be studied as the one universally variable for all individuals. It can be seen from what has been said that the one constantly present, yet constantly variable environmental factor, is energy in the photic or visible-range of the electro-magnetic spectrum—or light. Is it possible to show that variations in this photic range can and do have effects on functional activity and if so, what is the mechanism whereby functional variations are brought about? That is the problem we have under consideration in discussing the subject of Syntonics.

Your writer now believes, as a result of the study of available literature, and of the clinical use of Syntonics, that by altering or controlling the frequency of the photic range of the electro-magnetic spectrum incident into the eyes, it is possible to not only alter function, but in a larger degree to predict the extent of such alterations in functional activity.

A proper approach to this problem would entail a vast amount of time. There is a large mass of material available. You will understand, therefore, that a complete building of the background for a proper pres-

entation of the subject here is impossible, so that I must ask you to bear with me if what follows is not much more than a bare outline. To proceed then with our subject, we shall have to touch briefly upon the physics of light, the thalamus, the autonomic nervous system and endocrine gland function.

While it is true that Newton's theory of light (which held that white light was composed of seven different colors decomposed by a prism) did apparently fit the facts as he observed them; it is now known that white light consists of trains of irregular pulses of energy in space. The colors of the spectrum are actually brought into being within the prism by its action upon these irregular pulses. Investigators today, while still retaining the wave theory, are almost compelled to believe in a modification of the corpuscular theory as well, as being the only way to explain some of the phenomena they have observed. While the wave theory is adequate to explain the reflection and refraction of light by curved or prismatic surfaces, it is entirely inadequate to explain what takes place when this same light is incident upon a photographically prepared plate. This phenomenon can only be explained upon the basis of a theory that light possesses mass or something comparable to mass, since a chemical change takes place with the incidence of light upon the bromide of silver on the plate. Now a chemical change really means the release or absorption of energy and can only be observed by its action upon mass. The solution ultimately arrived at, is that light must possess something comparable to mass, and cannot be wholly composed of waves if it is to prove capable of moving mass, even if it is so small a mass as an electron. I should like to discuss briefly, the "Electronic Theory" in order to make clearer this last statement that light is capable of moving even so tiny a mass as an electron.

The molecular theory held that if a particle of substance, let us say chalk, could be broken down into its tiniest portion, we would eventually have a molecule of calcium, carbon and of oxygen. The electronic theory holds that an atom of light in reality consists of an aggregation of negatively charged ions rotating in their orbits, about a positively charged nucleus. This nucleus having about 1800 times the mass of its negatively charged satellites. When any stimulus, any increase in energy, is applied to this atom (such as heat, pressure or an electrical current) its effect is to change the radius of curvature of the orbit through which one or more of the negatively charged electrons is rotating. Let us say, for example, that a particular electron is now rotating through a larger orbit than formerly, as a result of the application of some stimulus. The result is, that now the centrifugal force acting through a lengthened arc of rotation is lessened sufficiently so that this electron is no longer held in its orbit and flies off into space. The loss of one or more of these negatively charged electrons results in a change in the electrical charge of the whole atom. The reason for this is that the positively charged nucleus—just neutralized the negatively charged electrons so that the charge of the

whole structure was zero. With the loss of the negatively charged electrons, we now have a positively charged atom because the charge of the nucleus is greater than that of the rotating minus charged electrons. In the same manner a different stimulus applied to the atom might shorten the orbit through which one or more of its negatively charged electrons is rotating so that extra negatively charged electrons are attracted rather than lost, and now we have the resultant charge of the whole structure, a negative one due to the addition of negatively charged electrons. This process of the gain or loss of electrons is really the process of ionization. Upon it depends all known chemical reactions as well as the metabolism of the living unit. Without ionization function and life as we know it would cease.

The velocity of the electrons released, in the manner just described, is directly proportional to the frequency of the incident light. Thus with high frequency light incident upon a surface, there will be emitted high velocity electrons, with low frequency light incident, the electrons will be emitted with a lower velocity.

Sperti, of the University of Cincinnati, long ago demonstrated that under the influence of light electrons are released from atoms which enter into the composition of living cells and tissues. The significance of this finding is that the chemical structure of the cell can be varied by light incident upon, and absorbed by it, and what is more, the degree of change is dependent upon the frequency of the absorbed light. Let us consider this statement for a moment in conjunction with the fact that it has been demonstrated that, function of the organism as a whole, as well as of the tissues that compose it, is dependent in no small part upon a difference of electrical potential. We now begin to realize that to say that "light incident into a pair of eyes will produce functional changes" is not at all a preposterous statement, but one that is logical and can be supported by substantial proof.

You will begin to see, that if it is true that a "gradual loss of electrical potential difference, results in a loss of function of tissue" then an increase of potential difference will result in increased function, or a restoration of loss of function. The effect then of the incidence of light *is to increase potential difference* by a process of ionization. The degree depending upon the frequency used. References for the statements used so far are Behr—*"Atomic Theory,"* Wood—*"Physical Optics,"* Johnson—*"Spectra."* Reiche—*"The Quantum Theory."*

Leaving now the subject of the Physics of Light, I should like to touch briefly upon the Thalamus for the purpose of showing the mechanism by which functional activity is evoked. The thalamus is a bilateral organ consisting of a group of nuclei (dorsal thalamus) which are afferent in function, and two groups of nuclei (hypothalamus and subthalamus) which are efferent in function. (The mid-brain and thalamus, are sometimes called the old brain, since they are presumed to antedate

the appearance of the cerebral hemispheres and serve as their equivalent in the lower animals. The hemispheres are referred to as the new brain.) Seen from the dorsal side, the thalamus appears as two connected egg-like formations lodged at the very center of the cerebral mass. The dorsal thalamus receives the large sensory tracts from all the receptor fields (except possibly the olfactory) and distributes the impulses therefrom to various areas of the cerebral cortex. The lateral geniculate bodies in the thalamus receive fibers directly from the optic tracts and send fibers to the optic lobe of the cortex. In short, the nuclei of the thalamus can be classed into three large groups for receiving sensation from visual, auditory, and cutaneous-proprioceptive areas, and sending ascending fibers to specialized regions of the cerebral cortex.

Descending fibers from the cortex to the thalamus also have been distinguished. The ventral part of the thalamus contains efferent nerve centers, and is said to be a coordinating center for visceral reaction. The hypothalamus which is found in the ventral portion of the thalamus, has intimate anatomical connections with the medulla oblongata and with the sympathetic ganglia. The thalamic influence extends over the entire effector mechanism. By arousing the sympathetic ganglia to the emission of diffuse impulses to the endocrine glands, these ductless glands are made to cooperate with neural mechanisms in increasing all bodily activity. Reference for the foregoing statements is made to La Verne Freeman's work on *"Physiological Psychology,"* as well as Bard, *"The Foundation of Experimental Psychology"* and J. D. Lickley's *"The Nervous System."*

From what has been said, it will be seen then that the thalamus receiving sensations from the eyes mediate these afferent impulses by way of its ventral portion, stimulating activity not only in the viscera, but the ductless glands as well—coordinating the endocrine and neural mechanisms to increase bodily activity.

The reader will recall my reference to the fact that the ventral portion of the thalamus has intimate connections with the sympathetic ganglia. As is known, these sympathetic ganglia are parts of the autonomic nervous system which controls all plain or smooth muscle tissue and viscera in the body. It is this vegetative nervous system which maintains life in the individual. This act of living is roughly described by the term metabolism. This is a word embodying two antagonistic functions namely anabolism, or the up-building process, and catabolism, the destructive or tearing down process. This whole process of metabolism is under the control of, and dominated by, the autonomic nervous system. The anabolic phase, or that having to do with the up-building processes, is named the parasympathetic. This division has its nerve trunk origins in the region of the third ventricle in the brain, the region known as the diencephalon. The diencephalon extends from the optic chiasma anteriorly to the epiphysis posteriorly, and from the thalamus (previously described) superiorly and through to the corpora mammillaria, inferiorly.

This region particularly the nuclear groups in the hypothalamus, is in intimate connection with the pituitary gland, by nerve fiber connections and by a specialized portal circulation interlocking the blood supply of this portion of the brain with the pituitary gland. The effect of this interlocking is such that an afferent impulse reaching the diencephalon will be transmitted throughout its entire mass and all of its contained nuclei. The result of this arrangement is that these nuclei and functional control centers such as the respiratory center, the heat regulating center, the vasomotor center and the cardiac centers will respond over efferent paths. In other words, sensory impulses reaching the diencephalon set off motor responses of the nuclei and functional control centers mentioned above.

Out of this region of origin then we have the parasympathetic outflow by way of the 3rd, 5th, 7th, 9th and 10th cranial nerves. This parasympathetic, or craniosacral outflow in conjunction with the sympathetic proper, innervates all the viscera in the body. The division of the autonomic having to do with the catabolic processes is called the sympathetic or the thoracico-lumbar outflow. It antagonizes or checks the parasympathetic just described. It consists of two gangliated chains which receive white rami communicants from all the dorsal spinal segments and usually the first three lumbar nerves. It sends gray rami to the cord at practically all levels beginning with the superior cervical ganglion.

It might be well at this juncture to list some of the functions of each of the divisions of the autonomic when stimulated. First the parasympathetic when dominant, stimulated or overactive, does the following things, contracts pupil, increases lacrimation, decreases intra-ocular tension, increases accommodation, activates intrinsic eye muscles, causes esophoria reflexly, increases salivary secretion, slows heart, dilates arteries, decreases blood sugar, decreases respiration rate. The sympathetic when dominant stimulated or over-active, dilates pupils, protrudes eyeball, lessens lacrimation, increases intra-ocular tension, lessens salivary secretion, increases pulse rate, contracts arteries raising blood pressure, increases blood sugar, activates thyroid, pituitary and gonads.

Freidenberg in his work *"Endocrine Hormones and Vitamins"* in relation to the eye insists that by far the most numerous sensory stimuli which effect the autonomic by way of the diencephalon are those of ocular, or visual origin. This means in effect that all of the vital processes controlled by the autonomic may be made to respond in some measure to sensory stimulation of the autonomic via the diencephalon and the eyes.

I trust that it is becoming evident now that light incident into the eyes may stimulate the autonomic or vegetative nervous system and evoke a whole train of responses, not merely the few already mentioned. As a matter of fact, whenever the sympathetic division goes into action, it does so as a *whole* and elicits *all* of the responses for which it is responsible.

The action of the autonomic calls forth endocrine reaction. The sympathetic branch when stimulated, stimulates the thyroid, the medulla of the adrenals, the pituitary and the gonads. These endocrine glands in their functioning act much the same as an interlocking directorate, each of the ductless glands has an effect upon the others. When the thyroid is stimulated, there is bound to be response by the pituitary and by the adrenals and by all of the others to a greater or lesser degree.

Now to summarize, to fit the parts of this theory together so as to make a complete picture. We started discussing this problem of Syntonics by defining the term as being a state of harmony existing between the two antagonistic divisions of the autonomic. We asked "was it possible to infer that light incident into the eyes could effect functional activity, and if so, what was the mechanism by which it was accomplished?" I have sought to show first by an explanation of the electronic theory of light that a process of ionization actually takes place when light strikes, or is incident upon a surface. That cells and living tissues actually function by a process of ionization—that their functional activity lessens with decreased potential difference and increases with increased potential difference. Next was described briefly the thalamus and how it acts to mediate sensory impulses; then was described the origin and functioning of the autonomic to bring out the fact that thalamic control involves the autonomic. The writer has listed only a few of the responses that can be elicited by the autonomic in an effort to show the widespread series of reactions possible when the sympathetic or the parasympathetic division is stimulated. I quoted Freidenberg as my authority for the statement that by far, the most numerous sensory stimuli that evoke autonomic response by way of the diencephalon are those of ocular origin and lastly pointed out the intimate relationship that exists as between the neural mechanism of the autonomic and the hormonal or chemical mechanism of the endocrines.

I have presented no clinical evidence to support the contention that the use of selected frequencies of light in ocular work is of definite value. In fact, I have deliberately refrained from citing any cases of cures, as I firmly believe that clinical evidence is of little scientific value. Clinical experiments using proper controls are unquestionably of value, but a busy office is no place in which to attempt experiments. Nor do I believe that the paying patient is a proper subject for experimentation. Syntonics, as we practice it, is no panacea. It is a most useful adjunct to any practitioner who attempts to do something more than increase visual acuity. The latter to my mind is just a partial job and if optometry is ever to reach its proper place it will be by the practice of preventive optometry, not merely the application of lenses to increase visual acuity. If this paper has evoked on the part of the reader an interest in the subject that will incite him to go on and learn more about Syntonics, the author will feel amply repaid for his efforts.

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HEADACHES AND ANISEIKONIA*

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Introduction:

We are all familiar with the fact, not only from the literature on headaches, but also from personal and clinical experience, that the cause, or causes, of headaches are many and varied. We know that very frequently the eyes are a prominent contributing factor in headaches. It is reported on good authority[1] that John Milton, the famous English poet, who lived 300 years ago, suffered from headaches when using his eyes. William H. Robey, Clinical Professor of Medicine at the Harvard Medical School, in his book "Headache",[2] states that the eyes and constipation are the most common causes of headaches. Dr. De Schweinitz[3] states that "from 30% to 60% of functional headaches are wholly, or in part, due to eye-strain in the widest acceptance of the term." Osborne,[4] in a paper written just last year, makes the following statement: "The most frequent ailment of civilized people is headache, and after more than fifty years of the practice of medicine I have determined that more than two-thirds of recurrent headaches are due to defective eyes."

Statistics:

It is reasonable to believe that the various figures which have been given in the literature on the percentage of headaches due to ocular anomalies refer to iritis, glaucoma, and other well-known pathological conditions and include such functional errors as ametropia and heterophoria, but do not include the ocular condition known as aniseikonia, or unequal ocular images. The following statistics show that the factor of aniseikonia accounts for a number of cases of headaches.

TABLE I

INCIDENCE OF HEADACHES IN ANISEIKONIA

Total No. of Cases Considered	635	
No. of Cases Reporting Headaches	386	61%
(a) as a major symptom	317	50%
(b) as a minor symptom	69	11%

*Read before a meeting sponsored by the Inter-Professional Relations Committee of the New York State Optometric Association, Hotel Pennsylvania, New York City, April 28, 1940. Submitted for publication June 12, 1940.

TABLE II

RELIEF FROM HEADACHES REPORTED AS A RESULT OF AN ANISEIKONIC CORRECTION

Total No. of Headache Cases	386	
No. of Cases Reporting Relief	259	67%
(a) Complete Relief	170	44%
(b) Partial Relief	89	23%
(c) No Relief	15	4%
(d) Glasses Discarded	112	29%

These figures are on patients who were examined at the Dartmouth Eye Institute prior to January 1, 1939, and have had their aniseikonic correction anywhere from one to eight years. The estimated average length of time that the correction was worn is three years. The relief obtained by the patients was ascertained by the written questionnaire method, and no case was considered that did not reply to the questionnaire in a definite manner.

In one of the earlier papers[5] reporting on the first hundred cases examined at Dartmouth, we find the following figures on headaches:—78% of the patients referred for aniseikonic examination reported headaches; 21% reported complete relief, 56% reported partial relief, and 23% reported no relief from the correction of their image size differences.

It is to be recalled that these figures are chiefly on cases in which such anomalies of a pathological origin, or of a functional nature, i.e., ametropia and heterophoria, have been eliminated or corrected, and the condition of aniseikonia was the main factor not corrected.

Mechanism:

It would be most interesting to speculate on just how such a condition as aniseikonia—which is not a disease of the tissues or of the blood stream—causes headaches, because it seems that if the symptom of headache is due to an inequality of the ocular images, it must have some functional basis. Although we are not yet able to state definitely just how differences in the relative size of the ocular images are compensated for, this, as Dr. Lancaster states, "should not be regarded as cause for reproach, since even after many years, there is a serious lack of agreement as to the mechanism of accommodation"[6].

Relative to the mechanism of headache, Robey[2] states that many authorities agree that there is a derangement of the normal circulatory balance which may be due to constriction or dilation of the blood vessels, to pressure from a tumor, to nerve irritation, or to muscle inflammation. He further states that the nervous control of the circulation of the blood within the central nervous system lies in the pia mater, through which pass branches of nearly all the cranial nerves, including those nerves which innervate the various ocular functions. Chideckel[7] states that the perception of pain depends upon a unitary conductive system, as described by Tilney, and that there is a side path for pain conduction which lies dormant under normal conditions. He states that this theory is

adopted by most physiologists, and also that the theory that all headaches are the direct result of hypersecretion of the cerebrospinal fluid is gaining many adherents. Chideckel mentions that by combining these two theories, the mechanism of most headaches can be explained.

It appears from these and other authorities, that the mechanism of headaches, in general, is not too obvious. It becomes necessary, therefore, at least from a clinical viewpoint, to believe that a certain organ, such as the eye, is the cardinal contributory cause of certain headaches when therapy applied to that organ alleviates the symptoms.

Case Reports:

By the statistics which have already been presented, and by the individual case reports which are to follow, we wish to call to the attention of those interested in headaches that there is another ocular anomaly, besides errors of refraction and muscle balance, which must be considered when patients complain of headaches without any apparent organic cause. This other ocular anomaly which should be added to the already long list of "causes of headaches" is—*Aniseikonia.*

HEADACHES AND ANISEIKONIA

CASE REPORT No. 1

Mr. G.D.M., No. 8985, Preparatory school student, male, age 18 when first seen, November 28, 1939; complained of *headaches in forehead* and behind both eyes *following reading;* also for reading, some eye fatigue. With the headaches there was no nausea, dizziness or scotoma. These headaches had begun about two years ago but were more severe the past year. The severity and frequency of the headaches were quite proportionate to the amount of reading or studying he had to do. The family history was negative. He had been wearing glasses for the past eight years and his present correction was:

R. +1.00 D. sph.
L. + 2.00 D. sph. ⊃ + 1.00 cyl. x 78,
giving 20/20— O.U.

Recent physical examinations were negative. Our ophthalmoscopic examination was negative, and our refraction was

R. +0.75 D. sph.
L. + 1.50 D. sph. ⊃ + 1.00 cyl. x 90.
giving 20/15 O.U.

The muscle balance was orthophoria for distance with refractive prescription and 7 Δ exophoria for near. The ductions and depth perception were normal.

Tests for aniseikonia showed that the right ocular image was smaller than the left in the horizontal meridian to the extent of 1½% as a minimum and 8% as a maximum with either our refractive correction or his own glasses.

We loaned the patient our refractive correction with a size fitover of 1½% magnification x 90 over the right eye. Two months later he reported that he had had no headaches and no discomfort from reading. A recheck on the Ophthalmo-Eikonometer showed that he was much steadier and his "size amplitudes" were now from 2% to 3½% in the horizontal meridian, the right ocular image being the smaller.

We have changed the aniseikonic correction from 1½% to 2% axis 90 on the right eye and the patient has reported continued relief from headaches, as well as from fatigue from reading and other uses of his eyes.

Comments: This is a case in which the headaches were quite definitely associated

with the use of the eyes, and in which relief was obtained almost immediately, once the difference in the relative size of the ocular images had been corrected.

CASE REPORT No. 2

Miss D.T., No. 2259, female, freshman in high school, age 14 when first seen, October 5, 1936; complained of *frontal headaches* for about one year *following reading* of about one hour, also some eye fatigue, itching, and blur when reading. Physical condition was reported negative and there was no family history of headaches. No previous glasses; vision 20/15 in each eye; refractive tests showed emmetropia O.U. The muscle balance was normal, 1 △ exophoria for distance and 4 △ exophoria for near. Tests for aniseikonia showed that the right ocular image was relatively smaller than the left in the horizontal meridian to the extent of 2.00%.

As a result of the tests in October, 1936, the patient was loaned
R.E. 2.00% mag. x 90
L.E. Plano
which she wore constantly for three weeks, at the end of which time she reported that she had had no headaches and that her reading and studying did not bother her.

In June, 1937, (having worn the aniseikonic correction for eight months), the patient reported again that she had had no headaches and no significant discomfort from reading except a slight fatigue during examination week, which she attributed to studying at night later than usual.

We did not hear again from the patient until this winter (December, 1939,) which is over three years since we first saw her. The patient reported that she had been comfortable with the aniseikonic glasses, which she had worn practically all of the time, because she had found that when she removed the glasses, the headaches would return. The patient in the past few months had had to do more reading and studying and had begun to experience some eye fatigue and a few headaches; also the frame was beginning to be uncomfortable. Rechecking on the Ophthalmo-Eikonometer showed that the aniseikonic correction could possibly be reduced ¾% (i.e., from 2.00% to 1.25%); however, as the frame was out of adjustment, and as we wished to recheck the findings, we had the frame straightened and advised the patient to wear the same glasses for another week—which she did, but reported that although she felt better, she had had one bad headache after long studying. Again a recheck on the Ophthalmo-Eikonometer showed that the 2.00% mag. x 90 on the right eye was over-corrected by ¾%. Accordingly, we replaced the 2.00% lens on the right eye with a 1.25% lens, and since this change, she has been free from headaches and otherwise comfortable.

Comments: This is another case in which, from the history, the headaches were quite definitely associated with the use of the eyes. There being no refractive error or heterophoria to correct, but only a relative difference in the size of the ocular images, we can be quite certain that it was the correction of the aniseikonia which relieved the patient's headaches, especially since she found during the three years that the headaches returned if she removed the correction.

CASE REPORT No. 3

Mr. T.H., No. 1564, college student, male, age 21 when first seen, May 25, 1936, complained of *occipital headaches* occurring three or four times monthly *without any definite connection with the use of the eyes;* with the headaches there was nausea but no scotoma. These headaches had been present since childhood; his father had similar headaches all his life which had been diagnosed as migraine by several doctors. The patient reported that many thorough physical examinations had been essentially negative.

The patient had been wearing, for the previous 1½ years, the following glasses:
R. —0.25 cyl. x 90 (20/15—)
L. —0.25 sph. ⊃ —0.25 cyl. x 90 (20/20+)

The patient stated that these glasses did not influence his headaches. Ophthalmoscopy was negative. Our refractive tests disclosed:
R. —0.37 D. sph. (20/20)
L. —0.50 D. sph. (20/20)

Muscle balance was orthophoria for distance and 2 △ exophoria for near; ductions and depth perception were normal.

The Ophthalmo-Eikonometer showed that the right ocular image was relatively smaller than the left to the extent of 1.25% overall, i.e., horizontally and vertically.

We prescribed glasses which would correct the slight myopia and the 1.25% aniseikonia. The patient has worn these glasses since May, 1936, and has reported on numerous occasions since then, the last time being only about a month ago, that his headaches have been reduced considerably if he wears the glasses; he has experimented by leaving the glasses off for a time, only to find that his headaches are more frequent. In a period of a year and a half when wearing the glasses quite constantly he had only two headaches—as compared with three to four per month with his former correction. He has also reported that if he is not wearing the glasses and the headache begins, he can "cut the headache short" by putting the glasses on. He has found that once a headache starts without the glasses on, if he puts the glasses on, the headache will last only about three hours, as compared with 24 hours without the glasses.

Comments: Naturally, we do not wish to imply that an aniseikonic correction is a specific for migraine, but we think it advisable to state that, as in the case just mentioned, we may, by the correction of some ocular error, relieve some "trigger point" which at times sets off the "charge" giving rise to migraine-like symptoms. It does not appear possible to rid such patients of all their attacks, but to reduce in frequency and severity the occurrence of these attacks, for which the patient is of course grateful.

Technically, perhaps we should not continue to class a case as migraine, after it has been discovered that a certain therapy relieves the symptoms. The definition of migraine [2,8] implies that it is a condition for which a definite focus has not been discovered; therefore, once it is disclosed that the eyes are mainly responsible for the production of the migraine-like symptoms, the classification of the case must be changed.

The quite gratifying result in Case No. 3 does not augment our opinion to the extent that we regard aniseikonia as the principal factor in all headaches, because such cases as the next one serve to remind us that there are some headaches which must be migraine in fact as well as in definition.

CASE REPORT No. 4

Mrs. P.M., No. 1543, housewife, age 28 when first seen on May 20, 1936, at which time she complained chiefly of headaches for the past six years, which occurred at irregular intervals—that is, she might have two or three attacks in one week and then only one attack in two months. There was no positive family history of migraine, according to the patient. On an average, these headaches had been occurring about fifteen times per year. They did not seem connected directly with the use of the eyes, but would usually begin in the afternoon with the following characteristics: (a) heart would begin to beat faster; (b) scintillating scotomata, flickering lights, black spots floating in space; (c) pain over right eye. This pain would usually start when the scotomata would begin to disappear; (d) numbness of left arm and left side of mouth and tongue; (e) nausea. For two days following these attacks the use of eyes for reading, especially, is very difficult, as the print appears blurred and words seem to run together. The patient had consulted several physicians about these headaches, and the diagnosis was usually migraine. She was wearing the following glasses when we first saw her:

R. —3.50 D. sph. (20/15 —2)
L. —3.00 D. sph. ⌒ —0.50 D. cyl. x 180 (20/20+)

Our ophthalmoscopic examination was essentially negative; and our refractive tests gave

R. —3.75 D. sph. (20/15)
L. —3.25 D. sph. ⌒ —0.50 D. cyl. x 180 (20/ 15).

which was practically the same as the patient had been wearing. The muscle balance, fusion, ductions, and depth perception were all normal.

Tests for aniseikonia showed that the right ocular image was relatively smaller than the left to the extent of 1.00% overall. Lenses were prescribed which would correct the ametropia and aniseikonia. A year and four months later, the patient reported that from June, 1936, until July, 1937, she had had wonderful relief from the attacks of the migraine-like headaches, but that in the month of July, 1937, she had a series of these severe headaches lasting for about two weeks. She had, because of this sudden return of the headaches, consulted one of the doctors at the hospital, who could find nothing to account for the headaches, but tried some "injections for migraine" which, according to the patient, did not have any effect. The patient went to the optician to have the adjustment of the glasses checked, and it was discovered that they were considerably out of alignment. With the glasses in proper adjustment, the patient went without a headache for several months. The next written report we have of the patient's progress is on June 2, 1938 (two years after obtaining the aniseikonic correction), when she stated that since the series of severe headaches the previous year, in July, 1937, she had had no such attacks until May, 1938, during which month she had three bad headaches.

We thought it would be interesting, if the patient were agreeable, to have her wear different glasses with various aniseikonic corrections, to see if the migraine attacks could be increased or decreased significantly. Accordingly, during the summer of 1938, the patient wore various aniseikonic corrections, but not with very conclusive results.

(1) The size correction was put on the left eye, instead of the right eye, and the patient wore this prescription for one month, during which time she had one migraine attack.

(2) We tried the size correction on the right eye (where the tests indicated it should be), and although we wished the patient to wear this only for one month, she did not return for six weeks, during which time she reported she had had no headaches.

(3) Patient wore just the refractive correction for three weeks and had two bad headaches.

(4) We gave the patient a slightly different refractive correction (—0.25 D. sph. more O.U.), but without any size, thinking that because of the slightly better visual acuity, the patient might think the prescription better. The patient wore this four weeks and had three migraine attacks.

About this time it was thought that the patient was getting tired of this experimentation and it would be best if we gave her the best prescription and let her wear it.

(5) We gave the prescription with the size correction in the right eye, as the test indicated. Four months later, (February, 1939,), the patient reported only one headache, and this occurred after having fallen downstairs.

(6) Since February, 1939, the patient had a few (two or three) migraine attacks in July, 1939, two in January, 1940, one bad attack of nausea, but without the usual headache. She had no attack in February, and since having her glasses adjusted around the first of March, has had none to date (April 22, 1940).

Comments: Although the patient is of the opinion that during the four years she has had the aniseikonic correction, the frequency and severity of her migraine-like attacks have been lessened, she is by no means completely relieved, as the detailed record above shows. This, then, is a case which has been closely followed for a period of four years, and even though the yearly number of headaches has decreased about one-half, whether due to the ocular correction, or to some fortunate coincidence, there are still recurrent migraine attacks.

This next case again had symptoms peculiar to migraine, and had so been diagnosed. However, the local eye symptoms were more pronounced than in Case No. 4, and we, as well as the patient, were fortunate, in that a correction of the ocular errors relieved her symptoms.

CASE REPORT No. 5

Mrs. C.F.I., No. 8716, housewife, age 27 when we first saw her on November 2, 1939; she complained of various visual disturbances which prevented her from using

her eyes. These visual disturbances occurred previous to and following severe attacks of headaches with nausea and vertigo. For the past five or six years the eye symptoms consisted of scintillating scotomata; transient blurring of vision; pulling of eyes; and the feeling that her eyes, as well as objects looked at were constantly jumping or vibrating; this was especially marked when looking at objects which consisted of lines—such as a radiator or rows of print on paper—the movement seemed to the patient to be chiefly a lateral one. The asthenopic symptoms were practically constant, but were most marked before and after a severe headache. The occurrence of the headaches was somewhat variable, from one to four per month. No history of migraine in the patient's family could be elicited.

Before being referred here, the patient had undergone very thorough physical examinations, but nothing significant enough to explain her eye and head symptoms was found, and a diagnosis of migraine had been made on four different occasions by the specialists at one of the large city hospitals where the patient had been observed for over a period of a year and a half. The patient was wearing the following glasses:

R. +1.00 D. cyl. x 90 (20/15)
L. +0.75 D. cyl. x 90 (20/15)

She had had numerous corrections since the age of sixteen, without significant relief. Our external examination of the eyes showed only a slight chronic conjunctivitis and blepharitis. The pupils reacted normally; tensions were normal; no nystagmoid movements; normal versions; and the ophthalmoscope showed the media clear and the fundi negative. By retinoscopy and subjective tests the following refractive error was determined:

R. + 1.75 ⌒ —1.00 x 180 (20/15)
L. + 1.75 ⌒ —1.00 x 180 (20/15)

With this correction, the phoria for distance (20') was orthophoria to ½ Δ exophoria, while for near (16"), there was 3 Δ to 4 Δ exophoria; the ductions were also within normal limits, and the patient had 100% depth perception on the calibrated Keystone card.

The tests for aniseikonia were made using:

R. + 2.00 ⌒ —1.25 x 180
L. + 2.25 ⌒ —1.25 x 180.

since it was found on the Opthalmo-Eikonometer that this correction balanced most exactly the conjugate foci of each eye. It was found that for distance, the right ocular image was relatively smaller than the left to the extent of 1.00% overall (i.e., both horizontally and vertically), whereas for near, the right ocular image was relatively smaller than the left, in the vertical meridian, to the extent of 1.00% and in the horizontal meridian, to the extent of 1.75%.

We loaned the patient a temporary pair of glasses correcting her ametropia and aniseikonia, and she reported six weeks later that she had not had a single headache, and that she had been able to use her eyes with comfort for even such tasks as reading and sewing, which had previously been impossible. Our recheck on the Ophthalmo-Eikonometer gave substantially the same findings as before, although it was noted that the patient was much steadier and able to make finer judgments, such that the difference between the distance and the near findings was now only 0.25% compared with 0.75% in the horizontal meridian on the previous tests.

Our next report from the patient was *two months later*, when she again stated that she had been quite comfortable and free from headaches. She related something quite unusual in her letter, from which the following is quoted: "Apparently one of these headaches started in my sleep, for when I opened my eyes the scotoma was quite evident. Judging from past experiences I had had it for five minutes. I was really amazed—I had almost forgotten what a migraine headache was—but in a second that same panicky feeling was there and I dashed out of bed, put on my glasses and began to dress. It all happened so suddenly that it seems like a miracle—for inside of three minutes the whole thing had vanished and my vision was absolutely clear. Way in back of my eye was the dull throb of the tail end of a headache. I felt a bit of nausea, but in a few minutes I ate breakfast and found that my appetite was fine. This was the first

time in my five years of experience that a headache stopped for anything, so I do feel quite elated." The patient mentioned that on the night before this abortive headache, she had read a lengthy novel and also completed a cross word puzzle.

Comments: This is a case with symptoms very much like those of migraine. While working for a commercial artist at the age of about sixteen, the patient first began to have some nausea and vertigo, but no headaches. Glasses were obtained and the patient gave up her job with the artist to accept a position as governess, which she held for five years. Beginning when she was nineteen years old, the migraine-like headaches occurred, accompanied by visual disturbances which at first lasted only about ten minutes, but in a few years had progressed so that they lasted for several hours. It is interesting that it remained for the eventual correction of some latent hyperopia and aniseikonia to fully relieve the symptoms, despite the fact that numerous physical examinations, X-rays, basal metabolism tests, allergic tests, ocular and dental investigations, etc., were undergone by the patient before she was finally comforted by the correction of the previously obscure and unsuspected optical errors.

Returning now to a few cases of headaches quite definitely associated with the use of the eyes, the following details are those of a very simple and successful case.

CASE REPORT No. 6

Mr. N.G.M., No. 6237, engineer, male, age 34 when first seen September 19, 1938, at which time he complained of occipital headaches for the past six years, especially following the use of his eyes for close work. Family history was negative.

Recent physical examinations were negative. He was wearing the following correction:

R. 5.25 D. sph. (20/20)
L. — 5.50 D. sph. ⌒ —0.50 D. cyl. x 85 (20/20)

Our ophthalmoscopic examination was negative, and our refractive tests gave practically the same correction as he was wearing; that is,

R. —5.00 D. sph. (20/20)
L. —5.00 D. sph. ⌒ —0.50 D. cyl. x 85 (20/20),

and his muscle balance, with correction on, was ½ Δ exophoria for distance and 2 Δ exophoria for near; the ductions and depth perception were also normal.

Tests for aniseikonia revealed that the right ocular image was relatively smaller than the left to the average extent of 1.00% overall.

The patient has worn the correction for his ametropia, combined with the correction for the 1.00% aniseikonia, for a year and a half, and reported recently (February, 1940,), that his headaches have been considerably reduced, and that such close work as drafting is now a pleasure, rather than a difficult task from which a headache was bound to be expected, as was the case prior to the correction of the aniseikonia. Rechecking on the Ophthalmo-Eikonometer in February, 1940, showed that we could not make any changes in his correction.

Comments: The next patient to be discussed (Case No. 7), is one who suffered from headaches for many years, and according to the patient, these headaches were definitely dependent on the extent of the use of the eyes. In contrast to some of the other cases reported in this paper, where it was necessary to make only one examination and one correction to obtain complete relief, in the following case, it was not until several examinations and corrections had been given that the patient reported complete relief.

CASE REPORT No. 7

Mr. R.J.B., executive of a manufacturing concern, male, age 34 when first seen, January 3, 1938, at which time he complained of headaches beginning in back of eyes

and progressing to the back of head for the *past fifteen years*. These headaches seemed to the patient definitely connected with any use of his eyes. He had been examined repeatedly by competent internists and nothing organically wrong had been found; the patient had also consulted several outstanding eye specialists during the past twenty years, and although he had worn various glasses, his headaches had persisted. No significant history of headaches in his family. When we first saw the patient, he was wearing the following correction:

R. + 1.00 D. sph. ⊃ —1.25 D. cyl. x 40 (20/25)
L. +0.25 D. sph. (20/15)

Our ophthalmoscopic examination was negative. Refractive tests gave the following prescription:

R. + 1.75 D. sph. ⊃ —1.25 D. cyl. x 40 (20/25) (20/20)
L. +1.25 D. sph. (20/25)

With this correction, the phorias were: for distance, 1 Δ to 3 Δ esophoria, with a trace of left hyperphoria; for near, 2 Δ to 3 Δ exophoria, with a trace of left hyperphoria. The fusion was poor and he could not get more than 50% depth perception on the calibrated Keystone stereopsis card.

Tests for aniseikonia on the Ophthalmo-Eikonometer were quite unsteady, due to the poor fusion and alternate suppression of the image of either eye, but roughly the right ocular image seemed to be smaller than the left to the extent of about one per cent overall.

Temporary glasses were made up and loaned to the patient. These glasses consisted of our refractive correction and the correction for the one per cent of aniseikonia. The patient wore these temporary glasses for nearly two months and reported that he had found he could use his eyes more, especially for reading, without getting the headaches in the occipital part of his head, but that the headaches in the regions around and in back of his eyes continued. Our recheck, two months after we first examined the patient, showed that he now could get 70% depth on the calibrated Keystone card, but the tests for aniseikonia with the Ophthalmo-Eikonometer were again very unsteady, especially at the near point, so that no very reliable measurements could be made. However, it was found that an add of +1.00 D. sph. O.U. for near was now indicated by the Dynamic Cross Cylinder tests, and by the settings for the conjugate foci of each eye by the optometer device attached to the Ophthalmo-Eikonometer.

As there was a significant difference, especially with regard to the near point, between our current refractive findings and the correction the patient had been wearing when we first saw him, and as the tests for aniseikonia were still not very reliable, we decided to try just a refractive correction, as follows:

R. + 1.75 D. sph. ⊃ —1.25 D. cyl. x 40
L. +1.25 D. sph.
Add for near + 1.00 D. sph. O.U. in a fit-over.

which we loaned him. He wore this for about six months, at the end of which time we again saw him and he reported that although he was more comfortable and more free from the headaches than he had ever been for the previous fifteen years, nevertheless he could not yet use his eyes as much as he would like, because the headaches, especially the frontal ones, would return if he tried to use his eyes outside of his office hours. We found at this time that he could obtain 90% depth perception and that his fusion was much better, so that tests for aniseikonia with the Ophthalmo-Eikonometer were much steadier than ever before, and the following correction was found:

R. 0.75% mag. x 180
L. 1.00% mag. x 90.

That is, the right ocular image was relatively smaller than the left in the vertical meridian to the extent of 0.75%, but in the horizontal meridian, the right ocular image was relatively larger than the left to the extent of 1.00%.

We therefore added to the refractive correction fit-over iseikonic lenses to correct the aniseikonia. Two months later the patient reported by letter that with the addition of the correction for aniseikonia, further improvement in the use of his eyes, without headaches, had ensued. The patient stated that he could hardly expect anything

better, and he wished the glasses made up in permanent form, which was done.

He reported, a year and a half later, that he had been practically free from headaches during this period. However, in the past few weeks, the headaches had begun to return. Our recheck in February, 1940, gave substantially the same findings for the refractive and aniseikonic corrections as before; his fusion was much better and he could easily obtain 100% depth perception on the calibrated Keystone stereopsis card. It was found that his frame was considerably out of adjustment and this was remedied. He has since reported that, with the glasses in proper adjustment, the headaches have not returned.

Comments: Summing up this case, then; first, we changed his refractive correction by +0.75 D. sph. on the right eye and +1.00 D. sph. on the left eye, and added a 1.00% overall estimated correction for aniseikonia; partial relief was reported, which was probably due to the increased spherical power (as we later found a different size condition); second, we added for near +1.00 D. sph. O.U., which brought a little more relief, still not complete; third, and finally, by adding a meridional aniseikonic correction, complete relief from headaches was realized.

Although one is justified in suspecting some ocular error is operative in the causation of headache when the patient relates that the headache comes with the use of his eyes, nevertheless, despite this clue and a careful history-taking which seemingly excludes other possible factors such as physical, neurological, allergic, and environmental explanations for the reported headaches, there are now and then cases in which both the history, symptoms, and ocular findings indicate the involvement of the eyes. Nevertheless, relief is not always obtained by an optical correction. Such a case is the following:

CASE REPORT No. 8

Miss G.R.J., age 28, telephone operator, was referred to us on January 10, 1938, because of headaches in the right frontal region which had been present for fifteen years with variable severity and frequency. There was seldom nausea and no report of any visual phenomena in connection with the headaches. Family history was negative. The headaches, according to the patient, seemed connected with the use of the eyes for work at the switchboard, for movies and for driving. As the patient did very little reading, she could not tell if that had any effect on the headaches. The patient assured us that her general health was good and that her last physical examination, as well as her dental condition, was negative. She had been wearing glasses for about five years, but according to the patient, they did not relieve the headaches.

The patient's glasses measured:
R. —1.25 D. sph. (20/20)
L. —0.75 D. sph. (20/20+)

Our ophthalmoscopic examination was negative. Retinoscopy showed R. —0.75 D. sph., L. —0.25 D. sph., and subjectively R. —0.87 D. sph., 20/20; L. —0.12 D. sph., 20/20. Vision without glasses was R. 20/100+; L. 20/25+.

Muscle Balance, with refractive correction, was orthophoria for distance and 6 △ to 8 △ exophoria for near. Fusion, depth perception, and ductions were normal.

Tests for aniseikonia, using the refractive correction of R. —0.87 D. sph.; L. —0.12 D. sph., showed the right ocular image relatively smaller than the left to the extent of 1.50% overall.

The patient was given the following correction, made up in single lens form, by varying the base curves of either lens appropriately to correct the aniseikonia:
R. —0.87 D. sph. ⌒ 1½% mag. overall
L. —0.12 D. sph.

In one month the patient reported by letter that the aniseikonic glasses had afforded *no relief* from the headaches. Four months later (June, 1938.) we were in-

formed by her doctor that the patient had recently had X-rays made of her teeth and jaw, which revealed three impacted molar teeth. When these impacted teeth were extracted, the headaches disappeared. Our last report from the patient (February, 1940,) states that since having the teeth extracted, she had been very comfortable and had but few headaches.

Comments: This is a case in which aniseikonia was not the factor responsible for the headaches. From the history given by the patient that her physical and dental conditions were negative, and that her headaches were related to the use of her eyes, we were justified, of course, in prescribing the correction for aniseikonia, since we found a significant amount. Fortunately, the patient, after eliminating the possibility that her headaches were due to some ocular anomaly, sought further attention from her dentist, and after the extraction of the impacted teeth, the headaches were relieved.

Lastly, in this brief presentation of "sample" cases in which headaches and aniseikonia are concerned, a case is presented which, similar to Case No. 2, had headaches in connection with the use of the eyes, and no physical or ocular anomaly other than aniseikonia.

CASE REPORT No. 9

Mrs. C.B., No. 7926, age 32, housewife, was referred to us August 10, 1939, because of frontal and occipital headaches which had been present for many years, but which had become more frequent and severe in the past three years, so that there was rarely a day when she was free from headaches. These headaches were aggravated by reading, sewing, and the movies. At times some nausea would accompany the headache, but there were no scotomata. Family history was negative. A recent thorough physical examination was essentially negative, and her oculist could find no refractive error and therefore did not prescribe glasses.

Our ophthalmoscopic examination was negative. Retinoscopy showed emmetropia O.U. The visual acuity was 20/15 —2 in each eye, and subjectively +0.25 D. sph. O.U. was all that would be accepted without blurring the vision.

The muscle balance was 2 △ exophoria for distance and 6 △ exophoria for near. Tests for aniseikonia showed that the right ocular image was relatively smaller than the left in the horizontal meridian to the extent of 2.00%.

Temporary glasses as follows:
R. Plano ⌣ 2.00% mag. x 90 (fit-over)
L. Plano
were loaned the patient. Two weeks passed and the patient returned for a recheck and to report that her headaches had been considerably lessened, although during the first week with the new glasses she was bothered by an increased nausea, but during the second week, she had no nausea and no headaches. The recheck examination gave substantially the same findings as in the initial tests. The patient wished to continue with the temporary aniseikonic correction, rather than invest in permanent glasses immediately. We permitted the patient the loan of the temporary glasses for another month, after which time she reported, by letter, that she was convinced that the glasses helped very much, and she now wished permanent glasses ordered.

In answer to our inquiry, the patient has again reported by letter (March 27, 1940,), having worn the aniseikonic correction seven months, that she has been "feeling fine, the headaches have left and that sick feeling to my stomach also."

SUMMARY AND CONCLUSION

It has been recognized that headaches are a symptom, not a disease, and while this may be a consolation to the doctor, it is not to the patient,

who feels that the "symptom" is as uncomfortable as if it were a "disease." Furthermore, while it is freely admitted in the literature on headaches that ocular anomalies are the cause of many headaches, nevertheless there are also many other causes. The recognition that ocular anomalies are the cause of some headaches includes, usually, the well-known pathological conditions of the eyes; the ametropic errors and the abnormalities of the muscle balance and fusion faculty, but does not include the recently investigated anomaly of binocular vision known as aniseikonia. Statistics and a sampling of individual case reports show that the condition of aniseikonia deserves to be considered in the etiology and therapeutics of patients who complain of headaches.

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REFERENCES

1. "The Life of John Milton" by Elizah Fenton, written as a Preface to "Paradise Lost." Published by Timothy Bedlington, Boston, 1820.
2. Robey, William H.—"Headache"—J. B. Lippincott Co., Philadelphia, 1929.
3. De Schweinitz, G. E.—"Ocular Headaches"—Bull., N. Y. Acad. Med., Vol. 1, No. 4, June, 1925, pp. 140-149.
4. Osborne, Oliver T.—"Headaches"—Vol. 149, No. 4, N. Y. Med. Record, Feb. 15, 1939, pp. 113-114.
5. Carleton, E. H., & Madigan, L. F.: Size & Shape of Ocular Images: II, Clinical Significance, Arch. Ophthal. 7:720-738 (May) 1932.
6. Lancaster, Walter B., Aniseikonia: Arch. of Ophth., Dec., 1938, Vol. 20, pp. 907-912.
7. Chideckel, Maurice—"Headache: A Review of Its Mechanism, Causation and Variations," N. Y. Med. Rec. May 17, 1939, Vol. 149, No. 10, pp. 339-342.
8. Allan, William, The Inheritance of Migraine; Arch. of Int. Med.—Oct., 1928, Vol. 42, pp. 590-599.

THE CORTICAL MECHANISM OF BINOCULAR VISION IN NORMAL AND ANOMALOUS PROJECTION*

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1. Corresponding Retinal Points.

In the study of normal binocular vision, the cortical mechanism of fusion of the two sensory presentations is of utmost importance. Not only do there exist many hypotheses to explain the complete or partial union of the two monocular visual sensations but the very question of whether there exists an innate retinal correspondence is still strongly debated. Such authorities as Duke-Elder favor the view that anatomical convergence of the visual paths has a motorial rather than a sensorial significance, a view which seems more acceptable because of the apparent existence of anomalous retinal correspondence in certain cases of squint.

In our discussion of "projection habits in alternate squints"[1] we have seen that, what has commonly been considered as anomalous retinal correspondence can no longer be regarded as such but must be construed as the absence of anatomical unification of the two monocular sensations initiated from corresponding retinal points, such stimulations being rarely, if ever, of identical nature. It is evident from these recent investigations that Herring's contention of the existence of innately corresponding retinal points cannot be discarded on the strength of anomalous projection cases. Another point of vital importance for the proper evaluation of the cortical fusion mechanism is the question of how binocular single vision is possible when objects fall on other than corresponding retinal points and whether fusion is still possible for a certain margin of disparity.

It is evident that, if the only connections between contraocular visual stimuli were along strictly corresponding fibres, all objects that do not lie on the horopter would be seen double, unless, as Verhoeff claims, failure to see two disparate images as two when they produce the effect of depth is caused by the complete replacement of one of the disparate images by its substitute. A more generally accepted theory, however, is the existence of corresponding fusional areas (Panum's areas) around

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[1]F. W. Brock: Projection Habits in Alternate Squints. Amer. Jour. Optom. Vol. 17, No. 5, pp. 193-207, 1940.

each pair of corresponding retinal points permitting fusion of all objects that lie within a certain specific distance of the horopter.

My own investigations along these lines agree with neither of these hypotheses but support Wheatstone (1838), Nagel (1861) and Wundt's (1863) contentions that true fusion of slightly disparate retinal stimuli does occur but that, during such fusion efforts corresponding retinal end-termini in these fusion areas become disparates.

The simplest experiment to support this assertion is the following: If two pins A and B are placed closely together on the fixation plane, the resultant binocular visual perception is that of two pins laterally separated and lying in this plane. If we now add two further pins C and D of different height than the first two, placing pin C closely behind pin A and pin D closely in front of pin B in such a way that they lie on the same unified visual axes as the original pins, the conscious perception is altered as follows: while steadily focusing on pin A, we experience very definitely the visual sensation of seeing pins A and D as single units, and pins B and C as double images lying equidistant on either side of the single pins. This situation is depicted in Figure 1. A and B represent two long pins situated in the anatomical horopter plane, while C and D show the positions of two shorter pins which have been placed along the unified visual axis intercepting the pins A and B respectively. The unbroken lines represent corresponding or conjugate visual axes, the dot and dash lines slightly disparate visual axes; the lines with single dots showing uncrossed, the lines with double dots crossed axes. The broken line indicates the position of the anatomical horopter. Fixation is assumed to be centered on pin A.

The efferent visual sensations as they were observed in the experiment, are projected from the cyclopean eye which represents the conscious center for unified binocular perceptions. It may be seen that the normally corresponding afferent visual axes which intercept pin A form a single unified efferent projection axis. Not so in the case of pin B. Here, evidently, the afferent corresponding visual axes have become non-corresponding efferent visual projection axes whereas the non-corresponding crossed visual axes intercepting pin D have cortically united into a single efferent projection axis, as indicated. The relative positions of the retinal images of the four pins as monocularly perceived are shown immediately below the two physical eyes. The unified conscious visual sensation is represented by the six images drawn below the cyclopean eye.

Many other experiments of this nature, described elsewhere,[2] pointed definitely to the fact *that true fusion of identical or nearly identical stimuli along slightly disparate retinal nerve fibres does exist and* that *it produces an equivalent disparity of normally corresponding retinal points.*

[2]Not yet published.

2. Quasi-corresponding Retinal Points

From what has been said before we must conclude that conscious unified perception is not always along anatomically corresponding retinal points. This does not necessarily mean that such unification differs in any way from that obtained along anatomically corresponding nerve fibres. The human brain, apparently, is able to vary correspondence within a certain definite small limit. However, no two points in the one retina may simultaneously correspond with any one point in the contraocular retina. If one remembers that depth perception is quite as accurate as vernier displacement, one must assume that, in the macular areas at least, there exists a rigid anatomical relationship between corresponding nerve fibres of the two eyes. Therefore, correspondence of slightly disparate fibres, when it occurs, cannot be primary but must secondarily occur after the primary visual impulses have passed the monocular visual centers in the cortex. It must be assumed that a single retinal terminus in the one eye may secondarily correspond with a great number of contraocular termini lying within close proximity of the actually corresponding terminus. Any one of these may, through fusion-effort, become the quasi-corresponding retinal end-terminus relative to the particular contraocular visual end-terminus. Of course, only one fibre of this group may at one time be actually quasi-corresponding and then only to the occlusion of the anatomically corresponding fibre.

That such quasi-correspondence is definitely limited was shown in the following manner: A series of inverted V shaped figures were drawn on paper, the length of their legs remaining identical (3″) but the lower free ends varying from narrow to wider and wider separations in the different figures. An attempt was now made to fuse the two legs by holding the paper parallel to the horopter and bringing the crossing point of one's primary visual axes sufficiently above the paper plane and intermediate to the two "legs" so that the primary visual axes of each eye bisected alternate legs near their widest separation. See Figure 2.

It was found that fusion became rapidly more difficult as the spread of the V's legs increased and that it was soon quite impossible to retain fusion along the entire length of the inclined virtual line. As with wider separation the inclination in the to and fro direction increased, the fused portion of the virtual line narrowed more and more until, finally, it represented a mere point at the near end of this line. This point could only be fused by bringing a pencil point to the exact position in space where the two primary visual axes bisected each other. It was further noticed that, as the fused portion of the legs became smaller and smaller the stereoscopic effect was less and less pronounced until, when point-fusion had been reached, no stereopsis could be elicited in regard to the V shaped figure.

These experiments were repeated with many variations and the following conclusions were drawn: (1) Total fusion ability is limited to a certain definite angular disparity of more than 0.5 degrees and (in

my case at least) of less than 1 degree arc. (2) Fusion requires a definite mental exertion and fusion ability is adversely influenced by fatigue.

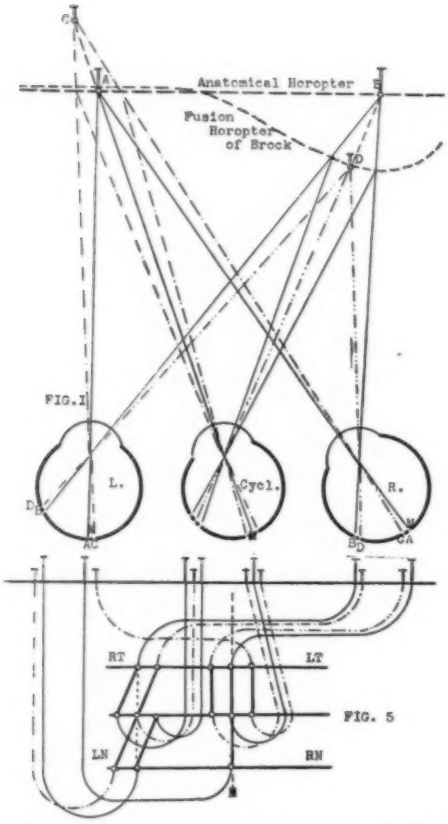
3. THE HOROPTER.

The horopter, as defined by Helmholtz, is the totality of those points in external space, whose images for a given position of the eyes fall on corresponding retinal points in both eyes. In considering these and many other experiments, I came to realize that the horopter, as defined above, can only be a mathematical concept and bears little resemblance to the imaginary surface formed by the projections of all quasi-corresponding retinal points as existing in normal binocular vision. In reality, the horopter of Helmholtz can only exist where there is a total lack of fusion-effort, and in normal eyes such a static condition seems as inconceivable as a complete lack of muscle tonus. It is, therefore, not surprising that all attempts at experimentally establishing the nature of the horopter plane must meet with almost insurmountable difficulties.

We should, I believe, consider the horopter of Helmholtz only as an ideal surface of reference and accept the fusion-horopter as the dynamic surface formed by the totality of those points in external space whose images for a given position of the eyes produce a unified percept throughout and therefore appear to fall on corresponding retinal points in both eyes. The marked difference between the theoretical horopter of Helmholtz and the fusion-horopter as conceived by myself is shown in Figure 1.

Experiments which I have described[2] elsewhere have brought out the fact that fusion seems to have a much greater faculty of drawing the horopter nearer to the observer than to extend unification beyond the theoretical horopter plane. This probability is also evidenced in the experiment described in Figure 1. Here, normal fusion includes the two nearer pins A and D and for the average person it remains almost an impossibility to bring pin C or pin B into the fusion horopter plane. Nevertheless, trained investigators of the horopter very often acquire the ability to inhibit fusion to such an extent that they can control their fixation to an unnatural degree and consequently their horopter approaches the theoretical horopter of Helmholtz to a remarkable extent. They are then apt to conclude that any variance with their own findings must be blamed on lack of accurate observation or an improper control. Verhoeff recognized this fact many years ago and it is to be hoped that others may do likewise.

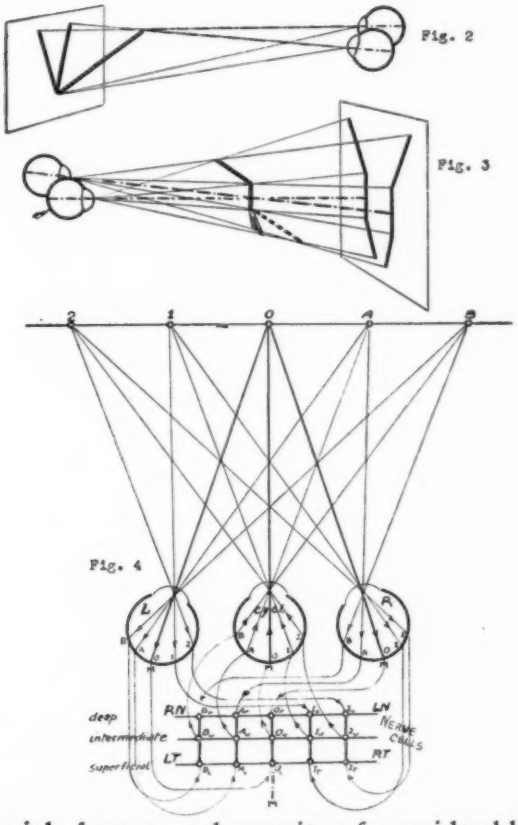
Normal fusion is more apt to include objects lying closer than the fixation point rather than those lying beyond. This peculiar phenomenon is clearly evident when one views a virtual (floating) line lying in the horopter plane and observes, without actually fixating them, oblique additions on both ends of this line extending at like inclinations to and fro along the median plane. One may then readily see that the oblique line extending toward the observer is, as a rule, seen singly while the



line extending away from the observer cannot be readily fused and therefore remains double. See Figure 3.

This points to the assumption that, as a rule, the fusion-horopter surface does not extend far beyond the fixation point but readily engulfs objects which lie nearer than this point. The fusion horopter may be likened to a hypothetical transparent sheet which molds itself whenever possible around objects within the fusion range of the observer. These horopter modulations, or depth differences are cortically perceived and are at least as accurately evaluated, if not more so, than vernier displacements (Duke-Elder).

According to this theory, only one point on any visual axis may lie on the fusion-horopter and it follows that two objects lying along the same visual axis, no matter how closely behind each other, cannot both be simultaneously and completely fused. Whereas, in any given position of the two eyes, the theoretical horopter is a permanent and unchangeable surface because it deals with anatomically corresponding retinal points, the fusion-horopter remains a constantly vacillating surface. This is so because it varies with the slightest change in position and amount of fusion effort being exerted, an effort which is entirely inde-



pendent of motorial changes and permits of considerable variations in anatomical quasi-correspondence. This variability may be of considerable importance in the cortical differentiation between crossed and uncrossed diplopia and thus, indirectly, in locating objects beyond and nearer than the horopter.

If it is assumed that fusion does not extend to points lying beyond the anatomical horopter plane, it is evident that through an increased fusion effort double images in uncrossed diplopia would be somewhat reduced whereas the separation of double-images in crossed diplopia would be correspondingly increased. This would undoubtedly hold true also for after images and conceivably even for memory images. It is then quite possible that this slight change in the relative position of double images of single objects can be cortically utilized to place the object definitely nearer or beyond the fixation plane. It has long been accepted that the brain is capable of distinguishing between crossed and uncrossed diplopia but, to date, no satisfactory explanation has been advanced regarding this phenomenon.

4. Existing Theories on Binocular Vision.

Any speculation regarding the possible cortical centers responsible

for the fusion ability in normal binocular vision and for the unified binocular perception as evidenced in certain squints must remain a hypothesis, as too little is known regarding the anatomy and physiology of the cortical centers. However, for a clearer conception of the conscious visual sensations resulting from given bi-retinal afferent stimuli certain assumptions may be made subject, of course, to revisions as soon as they may be proven invalid or as soon as a more satisfactory hypothesis may have been established.

In spite of the fact that present day conceptions do not look with favor on hypotheses which assume the anatomical union of the two sensations initiated from corresponding points and that they seriously question the existence of an anatomical "fusion center", they have not been able to give irrefutable evidence to the contrary. As main evidence against the existence of an inborn fusion faculty, which would have to be assumed if an anatomical fusion center were present, has been cited the existing anomalous projection in certain cases of squint (Duke-Elder). Verhoeff's and my own investigations of these cases have proven, and I believe effectively, that this argument has no basis in fact.

Ames, Ogle and Gliddon provisionally accepted the hypothesis of corresponding fusional areas (Panum's areas) around each pair of corresponding retinal points. Verhoeff, many years ago, on the strength of his own investigations, promulgated a somewhat similar theory, which at a later date, he modified materially in favor of his new theory of binocular vision which denies the existence of secondary retinal fibres. However, certain conclusions which Verhoeff reached in his new theory seem to me unassailable. These are: (1) That the two retinas in the brain must be accurately correlated. (2) That the two retinas are represented spatially in the occipital lobes. (3) That each retinal unit and its corresponding retinal unit must somewhere in the brain be represented separately, but that, when they are consciously perceived as a single unit, they must be represented by a single unit in the center concerned with conscious visual perception.

5. Henschen's Cortical Representation of Bi-retinal Stimuli.

Henschen, while tracing the representations of the two eyes in the visual cortex found that this area is made up of two layers, a superficial layer of nerve cells and a deep layer of nerve fibres. All these fibres appear to come from the external geniculate body. Henschen further claims that the superficial cells again divide into three separate layers which show a very significant arrangement. It appears that, when both eyes are lost in early life, both the superficial and deep layer become atrophied while the middle layer remains intact. If one eye is lost, the atrophy extends over the superficial layer on the same side and the deep layer on the opposite side of the lost eye. From this, Henschen deducted, that the middle layer is not directly related to either eye but is functionally independent and most likely the final receptor which correlates the cortical stimuli of

both the upper and the deeper layers which, in turn, connect with functionally related points of each retina. Henschen assumes that, if fusion is to occur, approximately corresponding cells in the deep and superficial layer must be stimulated.

If this is so it must also be assumed that the cerebral termini of retinal points lying on the nasal half of each eye must lay more or less directly under the cerebral termini of their corresponding retinal points from the temporal half of the opposite eye, separated only by the intermediate neuron layer which supposedly accomplished the unification of the separate impressions of the two eyes.

The simplest way in which one may schematically represent this concept of a right and left monocular cortical visual center, furnishing the necessary stimuli for a conscious unified visual sensation via an anatomical fusion-center, is to depict a hypothetical case where all retinal stimuli are along corresponding retinal points. Such a situation is presented in Figure 4. This figure shows how corresponding retinal stimuli are received by both eyes from the fixation point (0) and points lying in the left (1 and 2) and right (A and B) visual fields, but all on the anatomical horopter. It shows how these afferent impulses are relayed to their respective monocular centers, the right and left nasal areas being represented in the deep layer and the right and left temporal areas in the superficial layer of nerve cells. It further shows how these bi-retinal stimuli are unified in the intermediate layers and make up the efferent conscious visual sensations which appear to come from a single "cyclopean" eye. We know, of course, that this arrangement is not at all complete because it fails to take into account the fusion ability, the motor and psychic controls, which are all of equal importance for a satisfactory visual coordination and perception.

6. THE CYCLOPEAN EYE AND CYCLOPEAN CENTER.

As regards the existence of a cyclopean cortical center for unified binocular perception, opinions are united. There can be no doubt whatever, that our conscious visual perception is a unified percept, making use of the afferent stimuli of both eyes. There is, however, a decided difference of opinion as to whether this unification is of an anatomical nature and takes place in one of the lower visual centers or whether it is accomplished on a higher level in the centers concerned with conscious visual perception. Just as we accept the horopter as outward evidence of retinal correspondence, so may we accept a hypothetical cyclopean eye as outward evidence of unified perception. The position of the nodal points of this cyclopean eye can be determined by establishing the focal point of the unified projection axes which must, by necessity, coincide. It seems to me that the position of these unified projection axes can be ascertained with sufficient accuracy to place the cyclopean eye somewhat intermediate to the two physical eyes.

To convince one's self of this fact one need only face a wall some two or three feet away and gaze with each eye along one of two parallel

strings extending from directly below each eye to this wall. If the gaze of each eye is directed along the string extending directly in front of it, the conscious visual sensation is that of three parallel strings, the outer ones running to positions temporal to the two eyes and the center (unified) string ending apparently at the bridge of ones nose. This central and unified string, then, represents approximately the direction of the primary unification axis.

There can be no doubt, therefore, that our conscious visual perceptions are projected from a point which corresponds with neither eye but which, nevertheless, seems to have a fairly definite position. However, if there is such evidence of a cyclopean eye from which all visual projections seem to emanate there must also exist a cortical representation of this eye which may then be rightfully termed cyclopean center. Dr. Verhoeff has personally pointed out to me, and I agree with him, that we must beware of a literal concept of circumscribed cortical centers because there is no evidence of the actual existence of cortical areas in that sense. As a matter of fact there is good reason to believe that they do not exist in any such measure. It is quite probable that the responsible cortical areas are distributed over wide areas and that they do not constitute independent and separate entities.

7. THE FUSION-MECHANISM.

Experimental evidence shows (1) that in unified binocular vision objects retain their accurate spatial locations relative to each other and relative to the cyclopean center; (2) that fusion must be a very orderly and systematic process; (3) that the direction of the deflection of closely adjacent afferent impulses may not vary greatly, much less be in opposite directions. All this permits of but one conclusion, namely that, given identical afferent stimulations, the conscious visual perception can never vary materially and then only to the extent of increased or decreased fusion effort. What may vary, however, and that to a considerable extent, is the conscious evaluation, or concept, of these visual perceptions.

We have seen that fusion seems to have but one possible effect on the horopter, namely to draw the horopter plane nearer in those areas where fusion occurs. In other words, all fusible objects must be between the anatomical horopter and the observer. This means that if an object lies no matter how near to the anatomical horopter plane on the far side, the entire horopter plane must be withdrawn sufficiently to include this object. This can only be accomplished by a definite change in convergence. Inasmuch as the fixation object normally lies somewhere between the farthest and nearest objects of sufficient attention value to create fusion desire, we must assume that the fixation point may be located anywhere in the space between the anatomical horopter and the maximal fusion area and that it is only on rare occasions that the fixation point lies at the far point of the fusion horopter. It is in fact questionable whether total fusion relaxation ever occurs.

As the disparateness (within fusion range) of the afferent bi-retinal stimuli originating from a single object in outer space is directly related to the consciously perceived spatial position of this object relative to the anatomical horopter, one may well assume a cortical mechanism which controls and takes cognizance of the direction and amount of deflection necessary to produce a more or less completely unified image of the object. Indeed, one may even assume the existence of a three dimensional representation (Verhoeff). All this evidence points quite clearly to an anatomical fusion center of very definite and specific properties.

Let us now consider the main arguments brought forward against the existence of such a fusion center. I have stated earlier that the most serious drawback to the general acceptance of such a fusion center has been the existence of anomalous projection. I have already pointed out that we need not further accept this as a valid objection to the possible existence of innate retinal correspondence. In the previous discussion relative to this visual defect[1], I have shown that, in the absence of normal fusion, a different type of unification may be accomplished on a higher cortical level. I have further pointed out that this unification does not depend on correspondence of retinal images of simple objects and that, when such correspondence is established by orthoptic methods, no unification can be accomplished unless it be via the fusion center. In other words, anomalous unified binocular perception is based entirely on the non-correspondence of identical retinal images and lacks both stereopsis and luster because these are specific properties of normal fusion. We cannot reasonably assume that fusion and this anomalous type of unification are different functions of the same cortical visual center. Further objections have been the variations and incongruities found in the measurement of the horopter surface and a condition known as retinal slip. It seems to me that all these conditions can be satisfactorily explained by the peculiar properties of the fusion-horopter which have already been discussed. Retinal slip, after all, is nothing more than a greater or lesser discrepancy between the fixation axes and the primary visual axes, a condition which, it seems to me, should be the rule rather than the exception.

8. The Fusion Center.

In considering the properties of an anatomical fusion center capable of fusing identical or nearly identical retinal stimuli received from the two eyes along corresponding, as well as slightly disparate, retinal fibres, we must keep in mind the quality of the conscious perception. Ames', Ogles', and Glidden's as well as my own investigations, have shown that there exists an exceedingly accurate relationship between subjective and objective space and directional values. It seems to me that the fusion theories brought forward by Panum, Verhoeff, and others are not specific enough to account for the marvelously exact spatial orientation of which we are capable. No theory can be considered adequate unless it makes full provision for the following observations: (1) Fusion, it seems, accomplishes a considerable and yet specific change in the horop-

ter surface in order to include certain objects not lying in the anatomical horopter plane. (2) Fusible objects must lie nearer than this horopter plane yet within a definite and limited fusion range. (3) Certain provisions must exist for bringing such changes in the horopter-surface to consciousness and to permit a subconscious evaluation of crossed and uncrossed diplopia.

For the sake of some concrete anatomical arrangement we may provisionally accept Henschen's suggested cortical representation of bi-retinal stimuli as a basis for a hypothetical cortical mechanism serving fusion in normal binocular vision. No contention is being made that Henschen's deductions regarding the three layers of the superficial layer of nerve cells of the visual cortex are necessarily correct, the only essential assumption being that there exists a monocular cortical physiological center for each eye and that there further exists a fusion center for the purpose of unifying the retinal stimuli received. It is assumed that these stimuli are at least subconsciously perceived as received by the two monocular centers and that they are acted upon by the higher psychic centers in an effort to correlate these primary afferent visual impulses in such a way as to produce the most satisfactory conscious visual perception possible.

In the process of developing binocular fixation in anomalous projecton cases, I have come across a number of observations which strongly support the hypothesis that fusion is largely an involuntary process. I have shown that conscious unified perception in squint depends on retinal disparity of the images of single objects, whereas in normal binocular vision such images must occupy closely corresponding retinal areas. Nevertheless, it is often possible to shift the disparate image of an object in the squinting eye to within fusion-range of the contraocular image with the aid of prisms and lenses. In patients, where normal projection has been previously established, immediate fusion frequently results with demonstrable stereoscopic perception. This normal fusion, far from being acceptable to the patient, produces an immediate desire for diplopia and fusion is broken with such violence that the retinal images are thrown a considerable distance apart.

Let us see how the schematic representation of Henschen's nerve layer arrangement would have to be modified to include not only normally corresponding but also quasi-corresponding retinal points. As an illustrative case we may take the pin experiment shown in Figure 1. The top of Figure 5 shows the left and right monocular visual sensations produced by this situation and in between these two is shown the conscious binocular appreciation of the two non-corresponding monocular impressions. How the particular afferent impulses are thought to produce the observed efferent sensations is shown in Figure 5 where the monocular visual centers are represented in Henschen's superficial layers, containing the nasal halves of each retina (RN & LN), and the deep layer of nerve cells, receiving the temporal halves of the retinal visual tracts (RT & LT). Corresponding retinal end-termini in the monocular cen-

ters are again assumed to lie directly above each other and the center of the macular areas of the two eyes are represented by the dash and dot lines at M. Of the eight retinal areas affected, namely four in each eye, only three are represented in the superficial layer of nerve cells, while five are sent to the deep layer. In spite of the fact that two of the retinal images, namely A-A and B-B, are along exactly corresponding retinal points, only A-A presents a single unified percept after it passes the fusion-center. Fusion, apparently, forces the unification of the slightly disparate monocular images D-D with the result that B-B cannot be unified and reach the higher visual centers as unfused double images. The two visual images C-C, both being located in the deep layer of nerve cells, cannot be fused and they, also are retained as double images. Conscious perception is therefore as depicted in the cyclopean eye of Figure 1.

9. The Cortical Visual Centers in Normal and Anomalous Binocular Vision.

All the evidence which I have so far presented strongly supports my contention that in normal binocular vision there are at least three physiological centers active in the fusion of bi-retinal stimulations, namely the monocular centers and an anatomical fusion center. In anomalous binocular vision the latter center is entirely inoperative and unification is accomplished on a higher cortical level. This unificaton, far from being dependent on anatomical correspondence of the retinal images of single objects, can only function when such images are transmitted to the cortex along widely disparate retinal nerve fibres. This is so because the varying disparity of more or less identical contraocular images furnishes this psychological center for unified binocular vision with the necessary data for the proper evaluation of all objects lying in the binocular visual field.

According to this theory, it is assumed that the neural end-termini of the retinal fibres are spatially distributed in the monocular cortical visual centers according to a definite pattern so that corresponding retinal points are cortically in close relationship to each other, and that, connecting them, there is a system of neurons constituting the fusion center. This center must be considered capable of fusing bi-retinal stimuli varying within small limits both in character and correspondence. It must be assumed that (1) a more or less involuntary mental effort is required to accomplish fusion and that this effort varies in direct proportion to the disparity of identical bi-retinal stimuli; (2) that there exists a very accurate cortical ability to distinguish spatial differences in depth by the fusion effort necessary to unify varying degrees of disparateness; (3) that there exists a definite fusion limit and that fusion cannot, under any anomalous conditions, be accomplished along widely disparate retinal nerve fibres; and (4) that there can never exist any secondarily acquired anomalously corresponding fibres. In other words, fusion being accomplished along innately and anatomically related visual tracts cannot exist where binocular fixation along the primary visual axis does not exist.

I have shown elsewhere that fusion of disparate retinal end-termini can only be accomplished by creating an equal disparity in the normally corresponding end-termini. This suggests that there takes place a definite, systematic and accurately controlled deflection of these normally disparate retinal stimuli in the interest of fusion. This deflection is thought to occur in the transmission of these stimuli from the monocular centers to the fusion center. The fact that the fusion range is increased by fusion effort and decreased by fatigue permits of no other conclusion but that the fusion center is at least partly controlled by the higher psychic centers. This theory assumes that, in addition to the anatomical fusion center there exists a further unification center on a higher level which is capable of producing a unified conscious visual perception of identical retinal images received along too greatly disparate visual tracts to permit anatomical fusion. This may possibly be the reason why, in normal binocular vision, one may experience an almost total lack of awareness of physiological diplopia without consequent loss of adequate depth perception. We cannot very well explain the lack of physiological diplopia by total replacement of one of the images because, if this were so, depth perception of all objects beyond the horopter could not be greater than that obtainable in monocular vision. This, patently, is not so.

This type of unified perception must be considered a learned function as it actually constitutes a willful modificaton of accurate visual perceptions and represents, therefore, a concept rather than a percept. Inasmuch as this mode of unification lacks both stereopsis and luster these qualities must be considered specific functions of the fusion center.

In certain concomitant squints, where the horopter is either very closely in front of the eyes or, as in exotropia, is located behind the eyes, it is often impossible for the fusion center to become or remain operative and the higher visual centers must take over the function of unifying the retinal images over the entire binocular visual field. This, then, is known as anomalous correct projection. Verhoeff suggested that this might merely be a reversion to a more primitive mode of seeing. This is not an unreasonable assumption when we consider that the fusion ability appears to be a phylogenetically much newer order than other visual functions. It is quite possible, therefore, that at some stage of human evolution, the higher cortical visual centers might have been the only cortical unification centers in existence. Be that as it may, when a squinter learns to make full use of this mode of unification he has acquired the ability to interpret visual sensations of whatever nature in such a way as to gain as clear and as true a mental picture of the extrinsic world as lack of stereopsis will permit.

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Current Comments by Carel C. Koch

A Monthly Department

in which the Editor of the AMERICAN JOURNAL OF OPTOMETRY will discuss items of news of general interest: such as relate to new instruments, clinical techniques, education, public health, and optometric legislative and organization problems.

OPTICAL MANUFACTURERS ATTACKED

During the past six months it is becoming increasingly evident that the entire optical industry is being persecuted by certain bureaucratic department chiefs in Washington. That the heads of several important optical manufacturing and distributing organizations have been "under fire" is public knowledge, but the true facts of the matter have not been brought to light, nor has the public been given all sides of the important questions which have been raised by officials in our national capitol.

First we find the patriotism of the *Bausch & Lomb Optical Company* questioned, because of a scientific and technical working arrangement of many years standing with the *Zeiss Company* of Germany. An arrangement which was mutually beneficial to both firms, and also the technical optical development of both countries. We next then find a number of our leading manufacturers and distributors indicted for alleged infraction of certain marketing laws. In each case the press of our country has carried initial stories from Washington which have pilloried these fine companies and which have needlessly dragged their good names into the mire of distrust and suspicion.

As far as optometry is concerned the patriotism of the *Bausch & Lomb Optical Company* is unquestioned. This fine house, which has been admirably serving the needs of the optometric profession for years, cannot and must not be besmirched by a few apostles of the New Deal whose major thinking seems to center on the creation of a new order of things in America, and who are evidently doing everything in their power to bedevil and belittle the business institutions of this country.

The *Bausch & Lomb Optical Company* has for years supplied our army and navy with precision instruments necessary to the proper conduct of war. In fact, for many decades it has been our chief source of supply for range finders and other optical military equipment and has a long record of useful service to our country in this highly specialized field. This fact is brought out in a statement to the *Bausch & Lomb Optical Company* from the newly appointed Secretary of War, Mr. Henry L. Stimson, who says:

> "The relations between the *Bausch & Lomb Company* and the War Department, extending over a long period of years, have been most satisfactory from every standpoint. At this critical time, the War Department has complete confidence in your company for excellence of workmanship, productive ability and patriotic cooperation."

And too, the profession of optometry is standing by our distributors and manufacturers, who are "under fire," by reason of certain charges now made against them, due to marketing plans formerly in effect. To be sure, the officials of these concerns have had no opportunity of answering these charges, but if by chance there has been a minor violation of some federal statute we know our optical manufacturers and distributors will make proper amends.

For years optometry has been very well served by the *American Optical Company, Shuron, Bausch & Lomb* and other large makers of ophthalmic products and instruments. These companies have, time and again, proven themselves to be loyal and helpful friends of optometry in her struggles, and at the same time they have placed in our hands equipment and materials which played no little part in the splendid development of our profession. At this time, when these good friends are being attacked, the great profession of optometry stands firm in its trust and belief in these makers of optical and ophthalmic products and ready to assist them whenever possible.

The AMERICAN JOURNAL OF OPTOMETRY believes the close cooperation of the profession and the principal makers of ophthalmic products is a fruitful thing, which will continue to make America the foremost optometric nation on earth, and we will do everything in our power to encourage these fine, mutually beneficial associations, so that we can truly enjoy the greater accomplishments which can be expected of the future.

LANCASTER HEADS DARTMOUTH EYE INSTITUTE

The oculist Lancaster, of Boston, has been appointed Chief of Staff of the Dartmouth Eye Institute. Long regarded dean of American ophthalmology, Walter B. Lancaster will bring to his new duties at this clinical and research center, a wealth of experience to augment the already splendid staff of visual specialists who have already made this institution famous for their work in the field of correcting aniseikonia. The oculist Lancaster is a past president of the American Ophthalmological Society and also the American Academy of Ophthalmology and Oto-Laryngology.

QUACKERY

In May of this year, the Supreme Court of Minnesota, in a unanimous opinion, affirmed a ruling of the district bench of Ramsey County, that the order of the Minnesota State Board of Medical Examiners, in suspending the license of a Lake City physician, for five years, be upheld. The license was suspended by the medical board, following complaint made to them, by a former patient, who claimed that the physician attempted to diagnose cancer, brain tumor, stomach ulcer and other serious ailments by having the patient moisten a piece of wood pulp paper with saliva. This was then placed upon the abdomen of the patient

or if the patient was not available upon the abdomen of a woman in the employ of the physician, who then used certain diagnostic technics to make the diagnosis. The physician was also alleged to use an instrument to broadcast treatments to absent patients.

According to the medical board, the physician was twice warned to desist from such practices prior to the action suspending his license. In handing down its ruling the Supreme Court said, with reference to this physician's activities, that these were "so clearly bald quackery, and so much imposition on his patients that the testimony of three patients with whom he had had good luck would not have helped him."

Evidently medicine has its lunatic fringe, just as has optometry. The fact, however, that medicine occasionally suspends a license for this type of activity is welcome evidence of an official intolerance of the doings of these men. Public health is thereby safeguarded. State Boards of Optometric Examiners, have, we believe, the same powers, and should more often exercise these among those optometrists engaged in forms of optometric quackery.

SUBSCRIPTION NOTICE TO OPTOMETRISTS IN MILITARY SERVICE

During the coming years a number of optometrists will, no doubt, see service with the military forces of our country. To better serve these men, and to enable them to keep in touch with optometric activities, the publishers of the AMERICAN JOURNAL OF OPTOMETRY have arranged a special War-Time Subscription Service. A department which will devote its energies to making sure that the men in service, regularly receive all issues of this magazine, irrespective of the number of month-to-month changes of address and special individual mailings which may be necessary to keep up with the troops in training or in the field.

Subscribers who enter the military forces are urged to periodically send this department their new forwarding address, (Name and rank, service unit, ship or camp and mailing address) as changes occur in these. At no additional cost, journals will be individually mailed to these subscribers as this data is received, and back copies forwarded to them when this becomes necessary.

FORTUNE COMMENTS ON THE COST OF OPTICAL MATERIAL TO THE PATIENT

In the October, 1940 issue of FORTUNE magazine (pages 103-104), the staff of this business publication comments at some length as to the cost, to the patient, of optical material. The article is of significance to optometrists only inasmuch as it indicates four facts. These are (1) the excellent public relations job, which is now being done, for and under the guidance of, dispensing opticians. (2) That lay writers do not understand professional problems. (3) The inferiority complex of optometrists, and (4) the crying need for a public relations counselor to represent the optometric profession.

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A CRITICISM OF HEAT TREATED PROTECTION SPECTACLES

Few optometrists have more than an academic interest in industrial safety, particularly that part of industrial safety relating to the protection and preservation of vision among workers of industrial plants. Industrial eye safety is a specialty not overly burdened with scientific problems and mainly involving technical problems such as rate of production, adequate illumination and the providing of safety devices and guards.

There is one angle of industrial eye safety however which is of prime importance to optometrists, and which involves certain optical and visual considerations pertaining to optometry. I now refer to the growing use of so-called heat treated lenses. Heretofore the custom has been to provide for workers exposed to eye hazards, goggles designed to protect the worker's eyes from injury by actinic rays, heat rays and flying particles.

In keeping with industrial progress, these protection goggles have

been improved until today there is a goggle providing adequate protection in each and every occupation. These goggles have been made available at most reasonable prices, well within the means of the workers whom they protect, and in most all instances the employer supplies them to his workers at his own expense. The goggles meet certain specifications made necessary by the hazards of the specified occupation. They involve no unusual visual processes and their selection and adjustment is purely a matter of industrial experience. They are now supplied to industry through industrial supply houses and that business can have no more than a sympathetic interest from optometrists.

An attendant problem has been the incorporation of an ophthalmic correction in the goggles of the ametropic or presbyopic worker. This problem has been adequately met in two ways. Where special protective combinations such as welding glasses are needed, an ophthalmic lens is mounted behind the protective glass, but more convenient and less expensive, the goggles are made sufficiently large to permit their being placed over the regular glasses. By the latter method the workman makes use of his regular glasses and performs the same visual adjustment to which he is accustomed.

In other occupations where the only protection needed is from flying particles, goggles large enough to fit comfortably are placed over the glasses. These goggles are made either of fiber or metal, have side shields for additional protection, and are suitably ventilated. The protective glass is a special hardened flat glass of adequate and uniform thickness. The manufacture of this glass is a specialty and factory process involving special technical experience. Not all hardened glass is equally hardened, and it is questionable if certain so-called hardened glass is sufficiently hardened to provide adequate protection in all industrial hazards.

Recently a new practice has come into vogue. This practice consists in grinding an ophthalmic correction in ordinary crown glass, but of a minimum thickness of 5mm., then heating this glass to its "critical temperature". It is then subjected to a stream of compressed air, thus cooling it suddenly. This heat treatment, as it is called, is supposed to harden the glass to resist breakage and scratching by flying chips of steel or emery.

At first, this process seems to be ingenious and would seem to fulfill the requirements of industrial safety. However doubts have been expressed, by others more qualified to judge, that this heat treating process does sufficiently harden glass of ophthalmic grade to fulfill all industrial requirements. There is also some possibility that in high power lenses, this hardening may not be uniform throughout the various parts of the lens because of the considerable difference in thickness. Of greater interest to optometrists are the optical considerations involved in the manufacture and wear of these heat treated lenses. These considerations are of three kinds:

1. There is a strong possibility that as the prescription for these lenses is obtained by neutralization, an error be made in determining the power of lenses required. The spherical and cylindrical components of a prescription are easy to get, but not so, certain specifications of base curves, decentration, prism combinations, etc., all of which have in certain cases an influence on the comfort and visual efficiency of the patient. These secondary components are often overlooked in neutralization.

2. The positioning of glasses has a marked bearing on the comfort of the patient and this is especially true of bifocal corrections. The fact that segment size and decentration is duplicated in the heat treated lenses means nothing, as these lenses are of different size and are used in larger frames, sitting much differently before the patient's eyes. As the patient is deprived of his optometrist's experience in the preparation of these safety goggles, his visual efficiency may be considerably curtailed by their design suitable in every day glasses, but unsuitable in a large safety goggle.

3. The effective power of a prescription ground in standard thickness is changed considerably when the same correction is ground with a minimum thickness of 5mm. If the lens be of medium or high power, the change in the power of the correction may be sufficient to render it useless. Lay persons are poor judges of these changes, unless the use of the glasses is accompanied by a marked decrease in visual acuity or by asthenopia. Because of the thickness, prismatic and cylindrical effects are introduced in oblique positions of regard, which may be a source of danger in certain cases. It seems rather ridiculous that in this day and age when the use of superfine lenses such as "corrected lenses", is advocated by lens manufacturers, that some manufacturers duplicate these super-refined corrections with heat treated lenses where the optical considerations are thrown to the winds.

These objections may be said to be technical and may be claimed by some to be exaggerated, but more obvious are the following objections: First, it is said that many workers having secured these industrial safety goggles which resemble an ordinary but oversize pair of glasses, later break their regular glasses; they then get in the habit of wearing their industrial goggles in the home for close work as they would an extra pair of glasses. With the reduced intensity of illumination prevalent in the home and the undesirable characteristics present in the goggles, this custom can only be objectionable from an optometric point of view as it reduces the optometrist's carefully worked out prescription to the equivalent of bargain counter glasses.

Secondly, while some plants furnish their employees free of charge with these heat treated goggles, in many plants, the employee pays for them out of his own pocket. This is an added and unnecessary expense, as protective goggles could be supplied at a much lower price. And also this added expense may come at a time when the worker is due for a re-examination. Being unable to afford the cost of a re-examination

and of new glasses in addition to the cost of the goggles forced on him by the management in collusion with some dispensing optical company, he has his old correction duplicated, and thus continues wearing an outdated correction at the loss of visual efficiency. In many cases, this plan of industrial safety thus defeats itself by causing greater visual inefficiency.

Now compare these objections to this system with the advantages of protective goggles worn over the glasses. The auxiliary protective goggle or hand shield merely interposes between the worker's glasses and his work, a uniform layer of clear heat treated glass of minimal thickness and parallel planes. This has no magnifying effect and the pupillary distance of the safety frame, goggle or shield is immaterial. He wears his customary glasses; glasses which have been designed for him alone to provide maximal visual efficiency under his particular occupation. He is accustomed to these glasses, to their feel and in the case of bifocals, to the position of their segments. His prescription may include a weak prism base-up or down, or in combination with a stronger lateral base prism. This prismatic element may mean the difference to him between relative comfort and freedom from eye fatigue. When the protective shield or goggle is added over his glasses, his visual habits need not be changed. Nothing is changed except the luminosity in the case of welding goggles.

The worker thus receives maximum utility from his glasses and when his work is over he does not continue wearing inadequate glasses as occasionally occurs when he has protective spectacles. When he is in need of a change of lenses, he is not subjected to the additional expense of changing his safety goggle correction and he can thus afford to change his spectacle correction more frequently. If the expense of a safety goggle increases the period between examination from three to five years, his visual efficiency must certainly suffer a proportionate amount.

It is therefore apparent that optometrists have and must take greater interest in the subject of industrial eye protection. This interest should evidence itself by advice to their patients and to industrialists on that subject.

Because of technical objections to heat treated lenses, optometrists should discourage their use by their patients. Conversely, as stock industrial protective glasses and goggles fulfill every requirement and are much lower in cost to the worker, their use should be encouraged. The companies making these goggles are willing to supply optometrists with their catalogues, so that they may intelligently recommend what is needed. Needless to say the optometrist should not dispense these goggles, unless special and unusual correction features must be incorporated in the goggle.

The use of fit-over goggles should be highly recommended whenever practical, and they are practical in an overwhelming percentage of

cases, because the patient still gets full benefit of the carefully worked out optometric correction. The indiscriminate duplication of correction without the supervision of the original prescriber is highly objectionable from a purely technical standpoint. The optometrist assumes responsibility for his patient's visual welfare and can carry out this responsibility only if he has complete jurisdiction in all ocular matters.

G. L. DUPLESSIS.

ORGANIZATION AND JURISPRUDENCE

by Clarence W. Morris

A department in which some of the organization problems of Optometry will be discussed and in which certain of the legal aspects of refractive work will be reviewed.

A REAL OPTOMETRIC HEADQUARTERS IN WASHINGTON

During the past four decades optometric history was made in the several state capitols rather than in the national capital. The individual state has been the locus of all optometric efforts in the past. During these years the American Optometric Association had no need of a headquarters in our national capital.

With the advent in recent years of bureaucratic administration in all fields including a national health program, Washington and what it stands for has developed into an entirely new significance to optometry. We find for the first time a legislative problem in our national capital and the fate of optometry no longer rests exclusively with the several state legislatures. We must now deal with a national legislature and a number of powerful bureaucratic agencies created by congress. Therefore, for the first time in the history of optometry, a need exists for a national A. O. A. headquarters in Washington.

With the creation of an entirely new sphere of activities in Washington vital to the existence of optometry, it now becomes apparent that it would be desirable to have a permanent A. O. A. headquarters in our national capital. In the past decade Washington has become the center, if not the symbol, of the struggle optometry must wage in the coming years to protect the liberty of our citizens to consult optometrists of their choosing.

Our national executive secretary's intimate knowledge of our problems, and his good judgment and experience could be used to greater advantage when placed in contact with problems at Washington. The collaboration of Dr. Kiekenapp and Dr. Dicus in Washington may prove to be of inestimable value to optometry.

The establishment of such a national optometric headquarters seems a logical step for an aggressive, alert national association. The transfer from the locus of the state to the national capital of so many of the activities vital to the future of the optometric profession requires a corresponding adaptation upon the part of *our* national association. This adaptation calls for the establishment of a national headquarters in Washington and the transfer of the executive secretary and his office to that city.

SPECIAL REPORTS

IS REFRACTION BECOMING A LOST ART?*

G. Henry Aronsfeld, Opt.D., D.O.S.
Houston, Texas

Through the kindness of the Editor, whom I met in London in 1926 and with whom I became very friendly, I receive regularly THE OPTICIAN which is one of the outstanding Optometric Publications in Britain. In the issue for July 12, 1940, there appears an item which caused me to do some retrospective thinking. This item is as follows:

> TITLES!
>
> The following are titles of lectures delivered at the recent convention of optometrists held in Vancouver: "The Psycho-Physiological Basis for Lens Application"; "Visual Incidence in Reading Disabilities," by A. M. Skeffington; "The Role of Experimental Psychology in the Seeing Problem"; "Size Constances, Ground and Pattern" by Dr. Renshaw; "An Introduction to Reconditioning as a Psycho-Metric Approach"; and "Fundamentals in Reconditioning" by Marguerite Thoma. It must be repeated—the convention was for optometrists!

Nothing is further from the writer's mind than to suggest that optometrists should not delve into and study carefully, those subjects which have a definite bearing upon the physiological and psychological phases of human vision. While it need not be true, if such study means that we are to be less attentive to the science and art of refraction, then the writer fears that the price which we pay for such added knowledge is too great. Let us repeat—we should learn everything that we can, from every source which is likely to improve our work and benefit our patients but we should not neglect those subjects which are peculiarly our very own. We believe that the following thesis is incontrovertible, namely, that the practice of optometry is founded on careful refraction supplemented by proper orthoptic training when this is found to be necessary for the comfort of the patient. Some sixteen years of experience as a member of a State Board of Examiners in Optometry, have convinced the writer that,

*Submitted for publication August 21, 1940.

in many cases, the niceties of accurate refraction are neglected. Let us then start at the beginning. How many refractionists make an accurate estimation of the uncorrected vision in each eye? And is it not true that what the patient sees and how he sees it is often an indication of what is to follow?

When we use the ophthalmoscope, are we content with the hasty glance at the fundus or do we make an exhaustive examination at various distances? Are we careful enough to check the highly important pupillary reflex in every case and do we carefully examine the lids, canthi and conjunctiva in every instance? When we use the ophthalmometer, do we take a hurried reading or do we take the reading several times and are we sure that we have eliminated the disturbing influence of the film of tears and of lid pressure? When we do our static retinoscopy, do we trust to luck or do we make an attempt based on sound physiological optics to have the accommodation as nearly as possible at rest?

When we make our subjective tests, do we rely on the objective findings with some modifications or do we make an exhaustive examination in order that the correction may be as nearly perfect as it is possible to make it? I have little patience with a correction such as +0.12 sphere ⌒ + 0.12 cylinder Axis 162.5 ⌒ .25 △ base at 37.5 for the simple reason that I cannot make myself believe that this is, necessarily, an accurate finding. There are, however, a number of methods which help us to reduce our correction to one of extreme accuracy.

When an approximate correction for distance has been found, do we make every possible effort to blur the vision back to say 20/100 and then try to balance the two eyes? Do we exhaust every means at our disposal in order to find the exact axis of the correcting cylinder and its proper power? Are we conscious of the fact that a slightly misplaced cylindrical axis may, in truth, give the patient more trouble than if his astigmatism were not corrected at all? Do we avail ourselves of all of the methods which have been proved satisfactory in order to get the weakest possible correction, in myopes, and still give good vision?

Do we make careful tonicity tests at far and near and have we worked out a reasonable method of estimating the reserves which the patient should possess in order that he may be able to cope with a heterophoric condition? Do we check our accommodation carefully so as to balance the two eyes and do we do this monocularly and binocularly and then do we make an attempt to modify our distance correction if this seems to be necessary? Upon what do we base the need for orthoptic training and how much information have we in order to have a fairly good idea as to what the normals really are? Have we stopped to consider that an estimation of the ductions at finite distances involves certain physiological combinations, the nature of which has never been satisfactorily explained? Have we tried to work out a satisfactory method which will give us our fusional reserves with as little accommodative interference as possible?

Do we give sufficient attention to the distance at which our patients are going to use their eyes and also the manner in which they are going to use them? Do we appreciate that dynamic skiametry is as valuable in presbyopic cases as in young patients? Do we realize that the success or failure of a bifocal correction is often determined by our dynamic finding which often gives us a qualitative estimate of the accommodation which can hardly be obtained in any other way? Have we been careful enough to find a reasonable method for determining the position of the segment in bifocal glasses so that the wearing of such glasses will cause the smallest possible readjustment and disturbance in the patient's formerly acquired visual habits?

Do we consider the subject of "practical optics" in the same light as a dead language after we have passed our State Board examination or do we apply the principles which we have learned toward the working out of a comfortable correction? Do we have a rule of thumb for the decentration of single vision and bifocal lenses and do we ever stop to think that the reading portion of bifocals is a *Combination* of the upper and the lower part and that a prismatic element may be created by either one or both? Do we remember, when we prescribe rather strong convex or concave lenses and center them for distance, that when the patient looks at the nearpoint a prismatic element may be introduced which may be fatal to the patient's comfort?

Do we pay any attention to the tilting of the patient's lenses and have we tried to find out which part of the patient's nose can bear the greatest pressure? Are we careful that the pads on the bridge are so aligned that no sharp edges will come into contact with the patient's skin? Do we make a careful effort to study the patient's features and prescribe glasses which will be comfortable, becoming and of the greatest usefulness? Do we remember that even white glass absorbs 7 per cent of the light and that this may have a material effect on a myope who is obtaining his first bifocals and who, previously, always took his glasses off for close work?

It is an old saying that a fool can ask many questions which a wise man cannot answer but the questions asked in this article are sincere, practical and germane to the science and art of refraction. Yes, by all means, let us improve our mental status and broaden the scope of our knowledge but, while we do this, let us not forget the moral of "'Acres of Diamonds" and neglect the professional field for which we have received intensive training. Whether we like it or not, optometry rises or falls in public esteem on the basis of whether the glasses which we supply or prescribe, are correct and comfortable.

It is perfectly true that the general public is becoming more eye conscious and, therefore, they are using more than formerly, a sense of discrimination in choosing the individual to whom they trust their eyes. Naturally, it follows that those who make the most careful examination will build up the best practices but as the end result of an examination,

in most cases, is a pair of glasses you cannot blame the public if they judge our work by the type of service which they receive from these aids to human vision.

Of course, we all have the cases which do not require lenticular assistance and in many of these the patient is highly satisfied when he finds that properly administered orthoptic training helps him to visual comfort.

Be that as it may, our general statement is true and, therefore, it seems to me that it behooves all of us to take stock of ourselves and of our methods and see whether or not we are putting into the art and science of refraction the best efforts of which we are capable.

Without desiring to stress glasses too much, let us take a final look at the viewpoint of the public. Glasses are tangible things and, therefore, they are easier for the public to remember and to associate with a man who supplied them. In our daily contacts, we can spread the message of eyesight conservation and eye care, and in no way can we convince the public of our sincerity than by putting our very best efforts into that which is our birthright — *the Science and Art of Refraction*. If this is done, then the question can be satisfactorily answered and we may reply with assurance, "Refraction is not becoming a lost art but a medium for progressive and constructive human endeavor."

DR. G. HENRY ARONSFELD,
301-303 SHELL BLDG.,
HOUSTON, TEXAS

PROCEDURE AND INSTRUMENTATION

by Guy L. DuPlessis

A department wherein discussions will be carried on relative to the value of various experimental and clinical techniques as employed by practicing optometrists, and also in which the instruments used by optometrists in various phases of their work, will be subjected to some critical evaluation.

THE SHURESETOMETER

The Shuresetometer is a multi-purpose instrument developed by the *Shuron Optical Company* for use by dispensers and optometrists who do their own dispensing. With it, the following data can be determined: Bridge style, bridge size, pupillary distance of each eye from the center line, lens size, arm length for Numount and Shureset mountings, lens shape and segment height.

The kit assembly consists of an assortment of four Shureset mountings with flexible eye plates. These eye plates are removable and made

in a variety of shapes. Some of these plates are etched for pupillary distance and segment height. By exchanging plates of various shapes the patient gets an approximate idea of the future appearance of the glasses. The dispenser eliminates a lot of guess work incidental to the length of arm, height of segment and differences of proportion between various possible lens shapes. The Shuresetometer is, in the writer's opinion, destined to receive enthusiastic approval from many optometrists.

CHANGE IN COLOR TEST STANDARDS

The present world situation has made the supply of Ishihara and Stilling color tests uncertain. United States military authorities have devised a new test material incorporating features of both, in addition to other features permitting the detection of color malingerers. The set consists of 46 charts of dot patterns similar to the Ishihara design and is available through the *American Optical Company*. This new test has received the approval of the United States Surgeon-General and makes this country independent of Japanese and German sources of supply, now practically unavailable.

A NEW FLUORESCING ULTRA-VIOLET LAMP

The Hague Cataract Lamp manufactured by the *American Optical Company* consists of a source of light rich in the longer wavelengths of ultra-violet rays and a filter to minimize visible and infra-red radiations. It operates from a transformer connected to the 110 volt supply. The lamp housing is small enough to be held in the hand of the examiner or in that of an assistant when used for surgery.

The peak of intensity of radiation is in the neighborhood of 3650 a.u. and when directed into the eye causes the crystalline lens to fluoresce. This fluorescence makes visible details of the crystalline lens not seen under ordinary illumination. The Hague lamp can be used to locate dislocated lenses, lens residue after cataract operation, to examine certain forms of cataract, to recognize fine corneal lesions when stained with fluorescein, or to detect slight lesions of the lids more or less invisible by ordinary light.

THE COSMET EDGER

New products in their experimental and developmental stages are usually handmade or at best made with machines that are rather crude compared with the later regular production models. In other words, machines are developed as the product is developed. The story of the Cosmet Edger is no exception to this generality. The new lens-edge designs were first fabricated by experts who had the desire to make rimless

spectacles more attractive and less conspicuous through a technical and scientific control of light reflections from the lens edges. The first of these new Cosmet Edges were produced by hand. As the demand for these grew and their use spread to all parts of the country, the research department of the *Cosmet Corporation* started development of a special edger with which these special edges could be produced in a more uniform manner by any laboratory technician.

A great deal of time was consumed in making a number of experimental edgers. Finally a comparatively crude machine that would do the required work was built. From these rough models the more finished plans were changed as found necessary through actual trial. When completed, the working model of the present automatic machine was then turned over to a designer with the idea of making it as appealing to the eye as possible. One machine of the finished design was then made and subjected to actual use, over a period of time. From this trial period some small but desirable changes were suggested. These were then made and the actual production of the new automatic lens edgers were started. These new machines enable an optical laboratory to easily supply a variety of lens edges for rimless spectacles.

ANNOUNCING THE DISCOVERY OF A NEW SOURCE OF ICELAND SPAR

A new source of Iceland spar or calcite, a valuable optical mineral heretofore imported from abroad, was revealed when officials of the *Bausch & Lomb Optical Company* announced they had contracted for the output of a new mine in the San Pedro mountains, northwest of Santa Fe, New Mexico. The discovery by a Mexican prospector of the new source of supply and the interest of Dr. E. M. Stanton, a Chicago optometrist, led to a subsidy by *Bausch & Lomb* through which operations have been carried on.

The scarcity of optical calcite has caused a world-wide search for many years, since the mineral is essential in the construction of all polarizing instruments. With the flooding of the Iceland mine at Helgustadir during the World War, this source which formerly supplied the world has been unproductive of fine crystals. Meager supplies have come from various countries, the most recent from Spain and South Africa, but the total volume offered for sale has been insignificant for many years.

Officials reported that the new mine had delivered more than five hundred pounds of fine calcite crystals within a period of three months, many of them weighing as high as 40 pounds. An analysis of the output of the new mine indicates that the United States now has a supply of calcite of high optical quality.

Calcite, or Iceland spar, is formed by a deposition of calcium carbonate from water solution, but the conditions necessary for the forma-

tion of transparent spar, rather than ordinary calcite, are not definitely known. The most important use of Iceland spar is for the manufacture of Nicol prisms, essential optical parts of polarizing microscopes, saccharimeters, colorimeters, polariscopes, and many other instruments vital to research and technology. This type of prism was designed by William Nicol, a Fellow of the Royal Society of Edinburgh, in 1828.

When a ray of light passes through Iceland spar, it is resolved into two rays of plane polarized light, each vibrating in a single plane perpendicular to the other. The two rays have different indexes of refraction which results in their following different paths through the crystal. This phenomenon can be observed by placing a cleavage fragment of calcite over a dot on a piece of paper. Two dots will appear. Upon rotating the crystal, one dot will revolve around the other. These two rays are commonly known as the ordinary and the extraordinary rays.

The Nicol prism utilizes these properties to provide a source of plane polarized light. The prism is constructed of flawless calcite in such a way that the ordinary ray is reflected and totally absorbed within the prism while the extraordinary ray emerges as polarized light vibrating in one plane only.

MONOTONE DISPENSING

The majority of optometrists who do dispensing find that the patient seldom has a positive opinion as to what style or type of frame or mounting is to be used to hold the necessary correcting lenses.

In many cases the patient leaves this decision to the optometrist, relying on the latter's experience and esthetic taste.

Recent years have produced a flood of structural designs in spectacles, some better than others, but not all suitable universally. Some optometrists at times seem to become enamoured with certain designs and use these over and over again, frequently without mechanical or esthetic justification. Their work thus acquires a sameness varied only by one detail: Rims or rimless.

Shell frames at one time were universal favorites; today, it is rimless, particularly of a certain design, regardless of the patient or the correction. While this is not a universal practice, it is suggested that optometrists who do their own dispensing use a wider variety of frame designs, both in gold and plastics, and that they put in to their work more individuality in their use of designs of rimless glasses, even if this means the occasional use of some of the older varieties.

INQUIRY AND EXPLANATORY NOTES

Through this department answers to technical questions dealing with orthoptic or refractive problems will be presented. These answers here published have been prepared by competent experts. Inquiries on postal cards and anonymous communications will not be noticed.

THE TRAINING OF AMBLYOPIC SQUINT CASES

To the Editor: What steps are necessary in training a case suffering from convergent squint in which the deviating eye also suffers from amblyopia ex anopsia? G. L., Detroit, Mich.

Answer: This question can best be answered by quoting from a lecture presented before the American Optometric Association, in June, 1932, by Dr. Julius F. Neumueller, who discussed this point in some detail. The optometrist, Neumueller, said, "The following steps lead to amblyopia ex anopsia and squint. (1) diplopia, (2) suppression of vision in one eye, (3) squint, and (4) amblyopia ex anopsia. The training for these cases must follow these steps in reverse order for attainment of single binocular vision. In any treatments for this condition the following five factors are necessary. (a) Attention, (b) intention, (c) intensity of stimulus, (d) recency of last stimulus, and (f) frequency of stimulus. The treatments for squint and amblyopia ex anopsia resolve themselves into both monocular and binocular exercises. The monocular exercises are (M1) occlusion of normal eye as much as possible, (M2) daily copying exercises using the amblyopic eye only, (M3) stimulation exercises, preferably with red, and (M4) mobility exercises for the amblyopic eye. These *monocular* exercises shall aim to reduce and finally eliminate the central suppression scotomata and to restore the interpreting quality of the higher visual brain centers. The *binocular* exercises consist of (B1) re-establishing affinity between corresponding retinal areas, (B2) simultaneous binocular visual exercises, to see with both visual centers at the same time, (B3) superimposition exercises, (B4) fusional convergence exercises and (B5) stereoscopic treatments to stimulate stereopsis."

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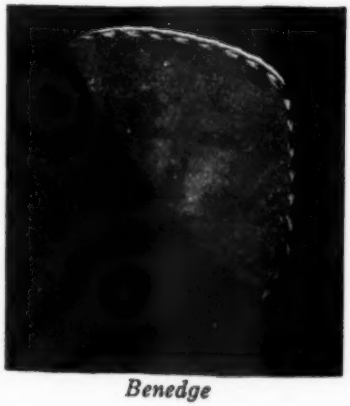

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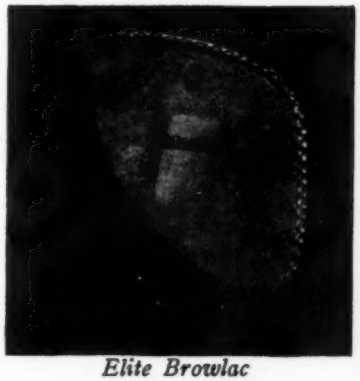

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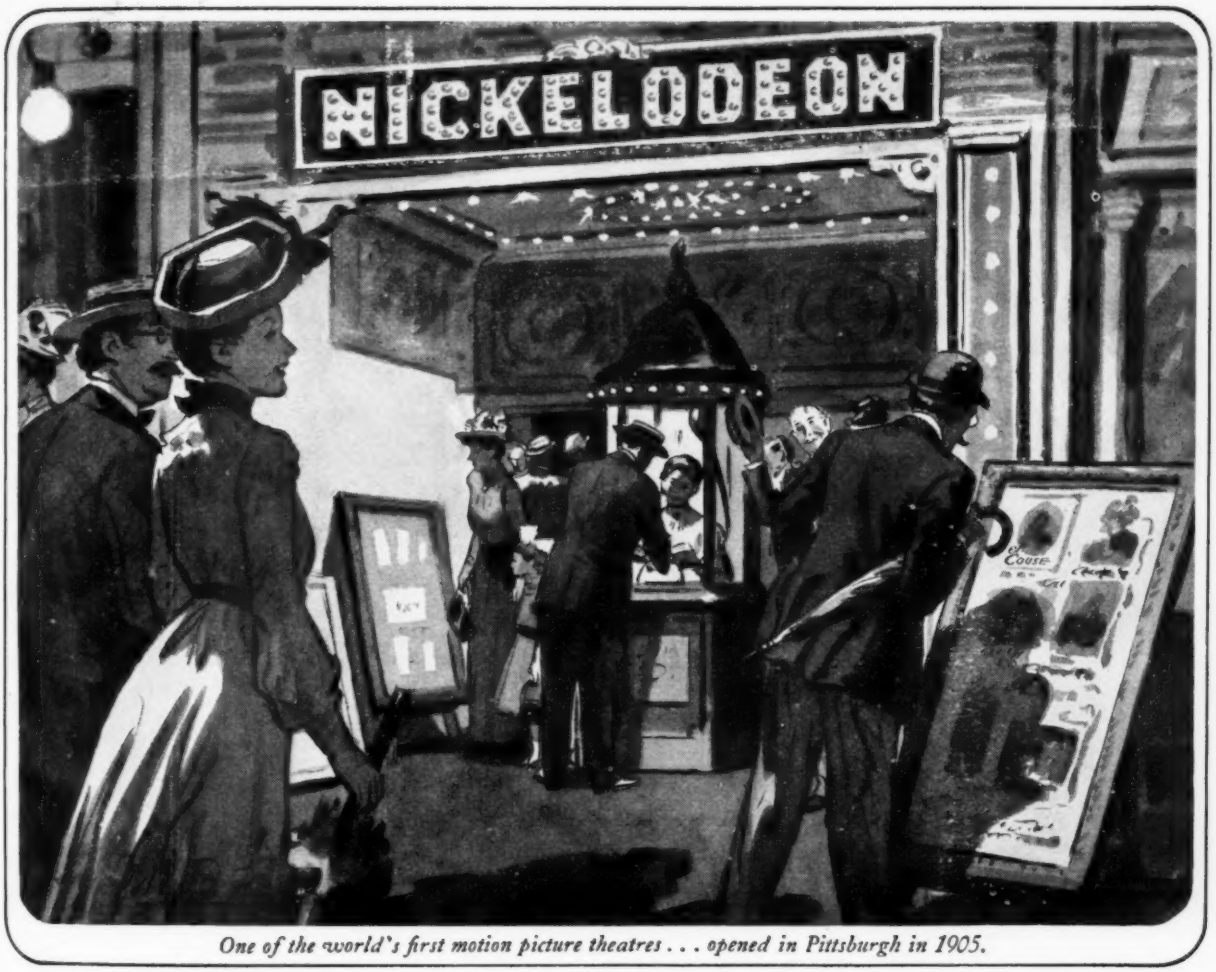

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